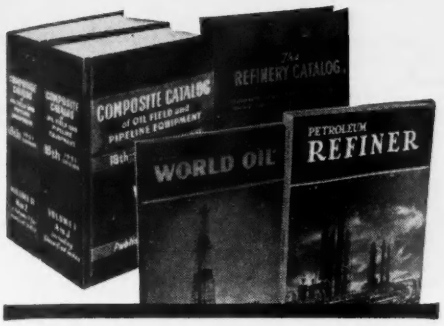

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for the drilling-producing-pipe line industry

PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

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WORLD OIL

Established 1916 as THE OIL WEEKLY

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Looking Ahead

WILDCATTING AND FIELD DEVELOPMENT will continue unhampered by reduction of income tax depletion allowance, following action of House Ways and Means Committee, voting down Treasury Department request for such reduction. General Ernest O. Thompson, Texas Railroad Commission member, said this Congressional move would help improve U. S. reserve producing capacity, which has been reduced to 435,000 barrels a day from 1,100,000 daily last August.

OIL AND GAS DEPLETION ALLOWANCE now appears safer than heretofore, in view of Ways and Means Committee's action in rejecting proposed reductions and recommending raise of coal's rate from 5 to 10 percent and granting allowances for first time to numerous minerals, including 5 percent allowance for sand, gravel, shale, shell, brick and tile clay, granite, marble, and stone and 15 percent for borax fullers earth, and other nonmetallic minerals.

CONTINUANCE OF CRUDE PRODUCTION around current levels is in prospect, with Texas June allowables about same as in May. Some Texas crude purchasers advised reductions to avoid storage problems, but majority recommended output about as ordered. U. S. crude stocks of 243 million barrels were described as unchanged from year ago in volume but down to 39 from 44 days' supply, due to increased demand. Chairman Olin Culberson of Texas Railroad Commission declared allowables should be kept up until stocks reach 250 million barrels, recommended as minimum by Petroleum Administration for Defense.

GOVERNMENT CONTRACTS to buy aviation gasoline, jet fuel, and other military petroleum products are advocated by spokesmen for PAD. The contracts are proposed as better than fast tax amortization for inducing oil companies to build enough new plant facilities to assure supplies required by military. Refiners meanwhile contend with shortages of sulfur and of tetraethyl lead for motor fuel, with metallic lead scarce.

NATURAL GAS WILL BE in extremely short supply next winter and in the next few years, perhaps adversely affecting defense production, due to inadequate line pipe for new lines under construction or planned. Less than two thirds of line pipe required in period immediately ahead will be available. Only about half of large pipe needed before winter to complete lines already under construction will be available.

SHARP DECLINES LATELY in tanker rates and ready availability of river barges are expected to have generally beneficial effects in oil industry. Summer movement of heating oils from Gulf Coast and Mid-Continent to Eastern and Northern distributing and consuming centers is encouraged, and ample supplies of gasoline are assured for areas far removed from refineries.

PACIFIC COAST MAJOR OIL COMPANIES await action of U. S. Supreme Court on their joint appeal from recent adverse lower court decision in their suit seeking stay of proceedings in current antitrust suit, pending final disposition of older, "Mother Hubbard" case against them. Meanwhile, trial in new case was under way in district court at Los Angeles.

STANDBY PLANS FOR GASOLINE RATIONING are contemplated by Office of Price Stabilization. The plans would be used in emergency, as in case of necessity of furnishing Western Europe deficiency that might arise from cutting off of supply from Iran.

Don't get caught with your circulation down!

JELFLAKE...the standard of the oil fields... is your best insurance against mud losses

Many experienced drilling operators find that conditioning mud with Jelflake is good insurance against mud losses. This tough, thin, fragmented plastic foil filters out on formation walls — seals off "thief" formations.

Jelflake is first choice for preventing or regaining lost circulation in many fields. It is quickly and easily used, holds its strength, will not ferment. Jelflake's crinkled surface prevents it from balling, and its low specific gravity allows it to remain in suspension in drilling mud for an indefinite time. Jelflake pumps easily through pump valves and circulating equipment, and its properties are not adversely affected by water, oil, mud chemicals, bacterial action or high bottom hole temperatures and pressures.

Jelflake is also used to prevent loss of cement slurry during cementing operations. Ask your nearest mud distributor, supply store or Dowell station for Jelflake, packaged in strong, wet-proof 25-pound bags.

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Keep ***Jelflake*** *Handy!*

Ask your nearest Dowell Station for complete information on these Dowell services and products: Acidizing, Electric Pilot Services, Plastic Service, Chemical Scale Removal Service for heat exchange equipment, Jelflake, Paraffin Solvents and Bulk Inhibited Hydrochloric Acid.

Look to **DOWELL**

FOR OIL INDUSTRY CHEMICAL SERVICE

"Petroleum Promotes Progress"

Editor's Page

HEADED FOR FEDERAL CONTROL

ONCE AGAIN THE OIL INDUSTRY is threatened with federal government control. The present threat is particularly dangerous because it constitutes a sidedoor attack on what at first glance seems to be a part of the industry rather than a direct frontal attack on the whole. The situation is made more serious because a four-man government agency which would do the regulating is also to render the decision.

After years of debate, the question of whether independent producers and gatherers of natural gas come under the regulations and directives of the Federal Power Commission is moving toward its first real test. The outcome, however, will have vital and far-reaching effects on oil producers as well as on gas producers.

The matter is coming to a head in FPC hearings on whether Phillips Petroleum Company is a natural gas company, and therefore subject to FPC regulation. Although Phillips is one of the largest and more important producers of gas, it seems likely that other producers who sell gas also would be subject to FPC jurisdiction. There are thousands of producers who sell some gas which eventually is transmitted through interstate pipe lines to consuming centers.

• • •

IF FPC DECIDES TO REGULATE natural gas production, wellhead prices, etc., such control necessarily must also cover control of oil production. Large quantities of oil are produced with gas. It would be physically impossible to control the output of gas in oil wells without also controlling oil production. So, if FPC can establish control over gas it has both feet in the door for the control of oil also.

It would be most unfortunate if FPC decides to regulate the sale of gas by independent producers and gatherers. Such action would cause serious harm to the oil and gas industry and to the conservation of this valuable fuel. Independent producers would be afraid to sell gas to interstate pipe lines, and many would refuse to sell their casinghead gas to avoid coming under FPC regulation. Waste of gas would be increased many fold in oil producing fields. Further exploration and development of oil and gas properties would be discouraged.

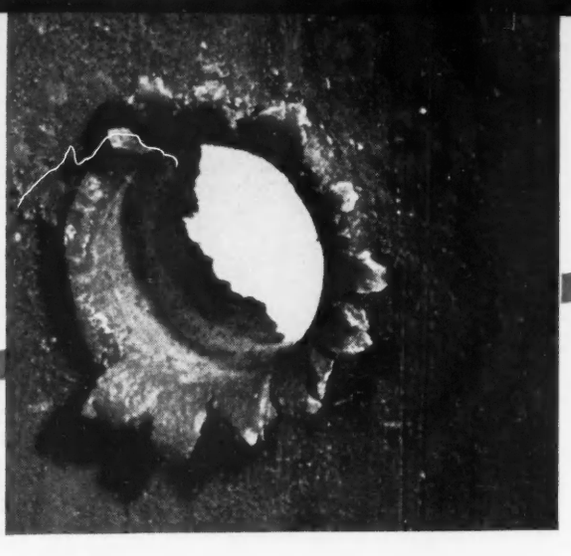
Prospects that consumers would benefit from FPC regulation are also dim. It is unlikely that consumers would realize their hopes of forestalling increased gas prices by having FPC fix maximum wellhead rates. Greatest cost to Northern and Eastern consumers distant from producing fields is not the wellhead price of gas, but the expense of constructing and operating transmission systems. The latter expense would remain unchanged under FPC control. Meanwhile, refusal of producers to sell their casinghead gas might so limit the supply that consumers in nonproducing states would not have an opportunity to enjoy the cleanliness, convenience and cheapness of natural gas as a fuel; and thus would bring upon themselves a grave injustice and the necessity of being forced to use more expensive fuels.

• • •

NOW, WHEN FPC HAS BROUGHT its fight for control into the open and when support of the Federal Administration is at a low ebb, might be an excellent chance to again revive a Congressional bill which would specifically exempt independent producers from FPC jurisdiction. Only President Truman's veto kept the Kerr Bill from being enacted. Such legislation might have a better chance now to be passed over the certain veto of the President. Whether the measure succeeded or not, such action would at least show that many of the states were strongly opposed to the actions of the FPC.

Warren L. Baker

DANGER



DO NOT RUN packers, testers, swabs or retainers

...until the "working surface" of your casing is clean

This typical burr resulting from a gun-shot hole, clearly shows why so many operators always consider it a "must" to clean the WORKING SURFACE—the vital inner wall of casing—with the new Baker ROTO-VERT Casing Scraper.

It is easy to see why tools with rubber cups, or a rubber packing element, many times fail to set properly, and often are cut, torn and hopelessly damaged while running-in the well. Ninety-nine times out of a hundred, premature setting of packers, testers and retainers, or their failure to effect a leak-proof pack-off, is due *not* to faulty construction or operation of the tool, but to burrs, cement, hardened mud, or other obstructions which . . . PREVENT PASSAGE OF THE SLIPS • CUT OR OTHERWISE DAMAGE THE PACKING ELEMENT; *or* • PRESENT SUCH A ROUGH, UNEVEN SURFACE THAT A LEAK-PROOF PACK-OFF IS IMPOSSIBLE.

The new Baker Model "C" ROTO-VERT Casing Scraper is a helix-blade-type scraper which can be either rotated or "spudded" (reciprocated vertically) for the removal of perforation burrs, imbedded bullets, cement sheath or other obstructions from the inner wall of casing. The body is machined from bar stock, with two sets of machined (not cast) blades positioned for overlapping, 360-degree scraping coverage.

The direction and angle of shear of the deeply hard-faced cutting edges is *exactly opposite* from other helix-blade-type scrapers, which means that the scraping edges of the ROTO-VERT will not "screw down" past burrs, but will actually *shear away* burrs, cement and other obstructions.

CHOOSE THE BAKER CASING SCRAPER EXACTLY RIGHT FOR YOUR WORK

The new ROTO-VERT Scraper is at its best where hundreds of burrs, with possible imbedded bullets, or unusually long stretches of hardened cement must be removed. It operates successfully *with* or *without* rotary equipment.

***For normal scraping,* where rotary equipment is present, the time-tested Baker Model "B" Casing Scraper, Product No. 620-B, continues the popular choice of many operators.**

Why not get in touch with your nearest Baker representative and secure specific recommendations for your next job? Or send for the new illustrated 28-page booklet which contains complete information on the important subject of Casing Scraping the Baker Way.

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Houston • Los Angeles • New York

BAKER

MODEL "C"

ROTO-VERT

CASING SCRAPER

PRODUCT NO. 620-C

Scrapes the "WORKING SURFACE" of your casing CLEAN and SMOOTH

The Changing Panorama

Ike's Book Explains His Shyness in '48

AN INTERESTING incident which possibly explains why General Eisenhower would not be a candidate for the Presidency in 1948 is given on page 444 of his book, "Crusade in Europe." The following paragraphs (dealing with President Truman while he was in Germany for the Potsdam conference) from page 444 are most interesting and enlightening:

"One day when the President was riding with General Bradley and me, he fell to discussing the future of some of our war leaders. I told him that I had no ambition except to retire to a quiet home and from there do what little I could to help our people understand some of the great changes the war had brought to the world and the inescapable responsibilities that would devolve upon us as a result of those changes. I shall never forget the President's answer. Up to that time I had met him casually on only two or three occasion. I had breakfasted with him informally and had found him sincere, earnest, and a most pleasant person with whom to deal. Now in the car, he suddenly turned toward me and said:

" 'General, there is nothing that you may want that I won't try to help you get. That definitely and specifically includes the Presidency in 1948.'

"I doubt that any soldier of our country was ever so suddenly struck in his emotional vitals by a President with such an apparently sincere and certainly astounding proposition as this. Now and then, in conversation with friends, jocular suggestions had previously been made to me about a possible political career. My reaction was always instant repudiation, but to have the President suddenly throw this broadside into me left me no recourse except to treat it as a very splendid joke, which I hoped it was. I laughed heartily and said:

" 'Mr. President, I don't know who will be your opponent for the Presidency, but it will not be I.'

"There was no doubt about *my* seriousness."

But as we understand the situation, the foregoing applied only to 1948!

Incidentally, we suggest "Crusade in Europe" as extraordinary good reading.

Truman Said It: Oil Man Should Boss NPC

OIL INDUSTRY MEN were encouraged when the President told his press conference May 17 that he believed the National Petroleum Council should remain just as it is—under chairmanship of an industry man instead of a government employe, as Department of Justice has been insisting.

Truman had been asked specifically whether he would "continue to let the head of NPC be an industry man or require that he be a government employe."

Truman's response encouraged oil men to hope that he also would grant Interior Secretary Chapman's request for exemption of all other oil industry advisory groups from Justice Department's requirement of government men for chairmen.

Labor Would Curtail Federal Encroachment

ORGANIZED LABOR'S opposition to government encroachment in the electric power industry should be encouraging to all Americans who treasure the free enterprise system as their way of life that must be preserved in business, housing, education, medicine, and other nonpolitical fields.

Government encroachment in electric power is actively fought by the New York State Federation of Labor (American Federation of Labor in New York State) in opposing the proposed St. Lawrence Seaway. The organization has 1½ million members and comprises electrical workers, all building and construction trades, all teamsters and chauffeurs, and most of the maritime trades. The electrical workers' union is particularly bitterly against government in the utility business. After having helped establish the Rural Electrification Administration, it could not secure in agreements with REA clauses that were standard in contracts with private companies. "Labor is getting a fair deal from these private companies," stated a union spokesman, "but we cannot secure equal treatment from REA."

In fighting the St. Lawrence Seaway, Thomas A. Murray, president of the New York State Federation of Labor, has stated: "We in the American Federation of Labor are opposed to any encroachment of government on privately owned and operated utility companies. We are opposed to all forms of authorities, such as the Tennessee Valley, Columbia River, California, Arkansas, Missouri, Ohio Atlantic Seaboard, and the St. Lawrence Seaway. Any form of government authorities, no matter in which state of the union, is in direct competition with free enterprise.

"Our unions call for curtailment of government encroachment into any form of free enterprise and the return of taxpaying privately owned companies, that have the right to expansion costs, without government intervention," Murray continued. "We in labor vigorously oppose the threat to our personal liberties for which we have fought in the past. We have learned that the first victims of public ownership are the labor unions and their members.

"At the present time, we are staging an all-out fight to defeat the contemplated St. Lawrence Seaway, and will continue to oppose all efforts that will endanger free enterprise," Murray declared.

Seeing Socialism?

"This England never did, nor never shall,

Lie at the proud foot of a conqueror,

But when it first did help to wound itself.

Now these her princes are come home again,

Come the three corners of the world in arms,

And we shall shock them.

Nought shall make us rue,

If England to herself do rest but true."

SHAKESPEARE

Report from the Observatory

DANGER SIGNALS CONTINUE TO GROW

By **RAY L. DUDLEY**, Publisher, and **WARREN L. BAKER**, Editor

TO AVOID EXCESSIVE STOCKS, the industry henceforth must once again exercise vigilance in balancing supply with demand. Unless refinery runs are curtailed immediately, difficulties with burdensome refined products are likely in the months ahead despite enlarged consumption.

Rapid growth of stocks, which have highlighted petroleum industry trends since March, will continue through June, Texas producing allowables having been continued at May peak rates. This action means substantially larger volumes will be in storage by the end of June than a year ago, making it essential that future producing and refining rates be watched with caution.

• • •

CHIEF DANGER rests in gasoline, although the industry now is in the motor fuel consuming season of the year. High production has created large stocks despite record consumption.

Highly significant was the reduction of posted tankwagon prices in the North Atlantic Seaboard area during the past month. Occurrence of this action at a time when motor fuel prices normally are improving constitutes a distinct warning that the industry has been operating at too liberal a rate. Prior to the posted price reductions discounts had become universal in several parts of the region.

At the end of March U. S. stocks of gasoline were at an all-time high of 142,186,000 barrels, and in keeping with normal seasonal trends were reduced to 132,742,000 barrels by May 19. However, it is significant that the rate of withdrawal during this period has averaged only 192,700 barrels daily in 1951 against a 222,800-barrel per day withdrawal in the same period of 1950. This reflects the higher gain in output than the increase in consumption. Consequently, gasoline inventories in mid-May were 8 million barrels greater than a year previous although they had been but 6-2/3 million barrels larger at the end of March.

• • •

ANOTHER DANGER exists in the current distillate fuel oil situation. In contrast with a slow rate of advancement in the corresponding period of 1950, U. S. distillate fuel oil inventories have risen sharply since last March. Excessive proportions will be reached before the heating oil season arrives next November, if the rate of growth is permitted to continue above 1950 levels.

Distillate stocks have risen five times more rapidly this year than during the same period of 1950, more than 5 million barrels having gone into storage since March 31 as compared with only 1 million barrels added the previous year. The daily rate of increase between March 31 and May 19 averaged 115,400 barrels in 1951 against only 18,300 barrels in 1950. As a result there were 48,826,000 barrels of distillate fuel in storage in the U. S. on May 19, an amount 9-1/3 million barrels greater than on the same date of 1950, although these inventories had been only 4-2/3 million barrels larger than year ago volumes on March 31.

• • •

CRUDE OFFERS NO DANGER, although these stocks also have been increasing rapidly in recent weeks. Since March 31 crude oil inventories advanced nearly 8½ million barrels by May 19, a daily average of 172,000 barrels. During the same period last year, crude stocks declined by 1700 barrels per day. Further additions to crude stocks will occur before the end of June in view of indicated producing rates.

Present crude stocks of 244-1/3 million barrels are 1-1/3 million barrels greater than a year ago, whereas at the end of March they were 7 million barrels less than in 1950. Advancement of crude inventories to 250 million barrels seems to be in order. However, the latter volume could be reached by the end of June if refinery runs are held to margins indicated as desirable by gasoline and distillate fuel stocks.

• • •

IMMEDIATE NEED is for crude runs to refinery stills to be held at safe levels. It has been alarming to see runs increase in May, after declining in April from peaks attained in earlier months. This can only aggravate the tendency of gasoline and distillate fuel stocks to become excessive. On the other hand, lower crude runs would have a very beneficial effect on these inventories, and in the face of high crude production would shift the increase in stocks to crude oil where it would not yet be harmful.

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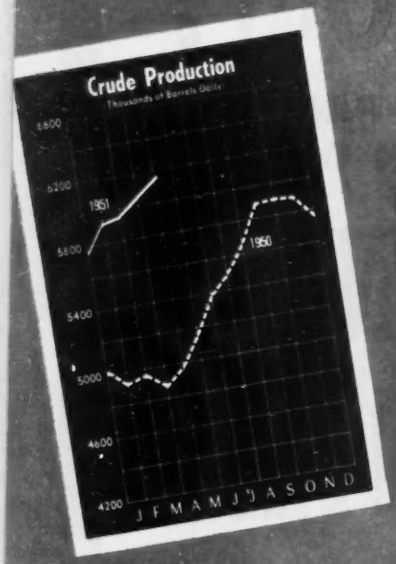
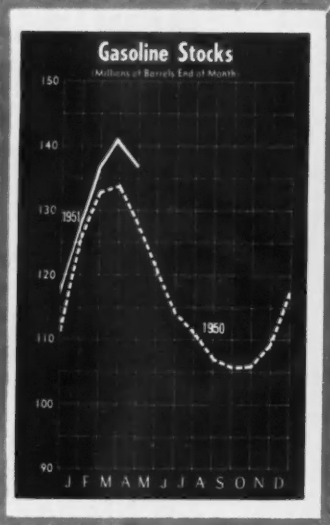
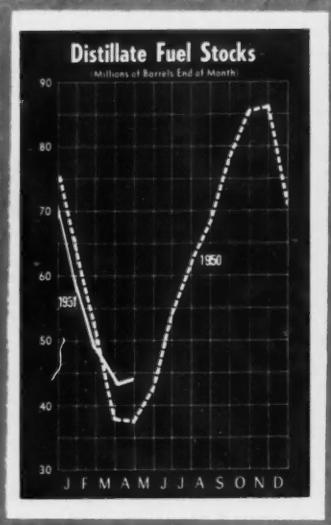
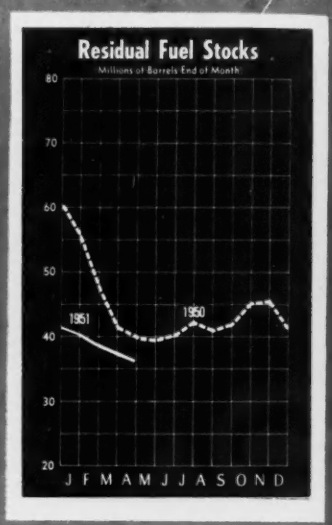
Petroleum

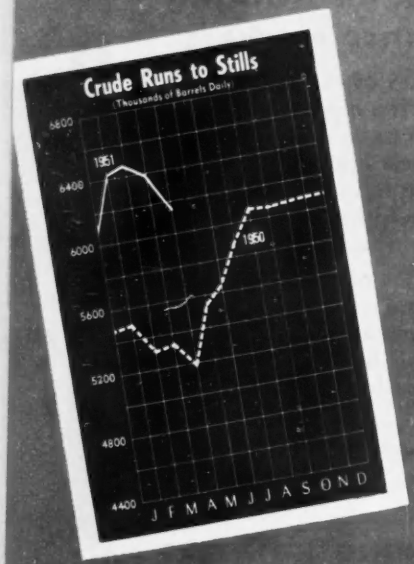
By CECIL W. SMITH,

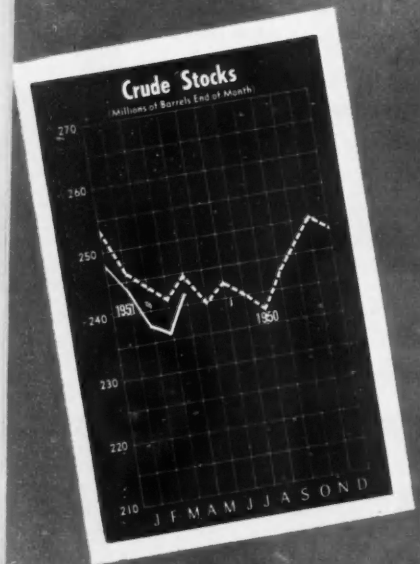












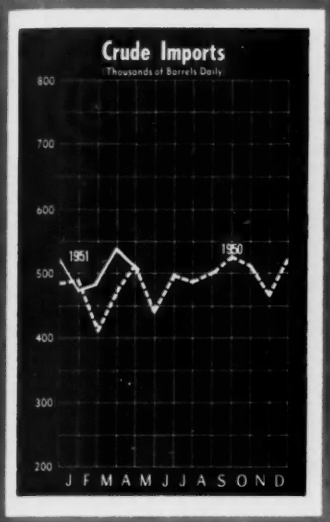
U. S. Crude Production by States

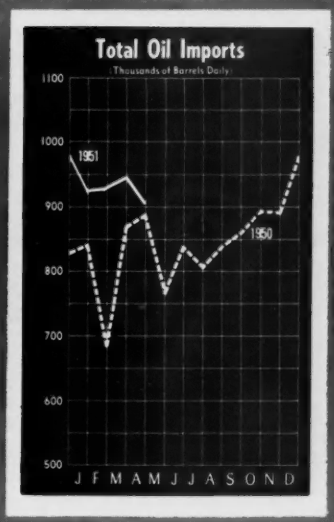
(THOUSANDS OF BARRELS)

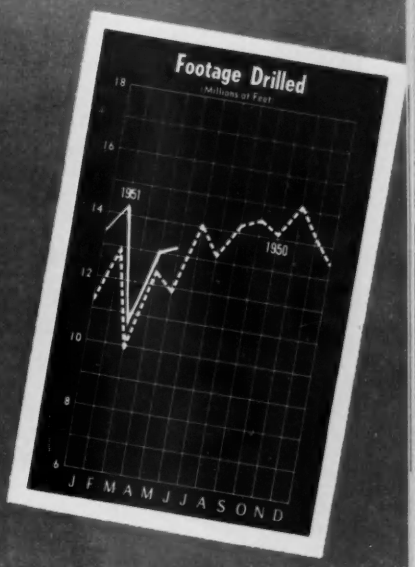
STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION First Four Months		
	April, 1951	March, 1951	April, 1950	% Diff. April, '51-'50	1951	1950	% Diff '51-'50
Alabama	2.8	2.9	1.6	+ 75.0	328	188	+ 74.5
Arkansas	81.4	82.3	85.5	— 4.8	9,831	10,296	— 4.5
California	966.1	967.0	857.8	+ 12.6	115,623	103,399	+ 11.8
Colorado	78.6	79.4	61.2	+ 28.4	9,221	7,269	+ 26.9
Florida	1.6	1.6	1.0	+ 60.0	189	122	+ 54.9
Illinois	160.6	165.4	168.0	— 4.4	19,420	20,450	— 5.0
Indiana	27.9	27.0	27.7	+ 0.7	3,107	3,140	— 1.1
Kansas	314.3	316.5	282.3	+ 11.3	37,243	33,687	+ 10.6
Kentucky	27.3	28.3	26.8	+ 1.9	3,348	2,979	+ 12.4
Louisiana	642.8	642.8	517.9	+ 24.1	76,123	65,364	+ 16.5
North Louisiana	129.2	129.2	123.7	+ 4.4	14,927	23,026	— 35.2
South Louisiana	513.6	513.6	394.2	+ 30.3	61,196	42,338	+ 44.5
Michigan	40.4	39.1	43.6	— 7.3	4,767	5,340	— 10.7
Mississippi	103.1	104.3	98.0	+ 5.1	12,468	11,839	+ 5.3
Missouri	0.1	0.1	0.1	.....	9	9	.....
Montana	23.8	24.5	21.5	+ 10.7	2,908	2,568	+ 13.2
Nebraska	9.6	10.2	2.4	+300.0	1,123	246	+356.5
New Mexico	142.3	139.2	125.0	+ 13.8	16,665	15,347	+ 8.6
New York	13.9	13.9	10.7	+ 29.9	1,526	1,352	+ 12.9
Ohio	8.4	9.0	8.8	— 4.6	1,020	1,088	— 6.3
Oklahoma	499.2	500.7	417.5	+ 19.6	59,832	48,752	+ 22.7
Pennsylvania	29.6	28.9	30.8	— 3.9	3,686	3,696	— 0.3
Tennessee	0.1	0.1	0.0	.....	4	8	— 50.0
Texas	2,767.8	2,654.4	2,013.9	+ 37.4	318,033	234,696	+ 35.5
Dist. 1—South Central	33.7	33.0	26.6	+ 26.7	3,935	3,134	+ 25.6
Dist. 2—Middle Gulf	165.9	160.1	120.9	+ 37.2	19,093	13,932	+ 37.0
Dist. 3—Upper Gulf	503.6	484.9	366.6	+ 37.4	58,110	43,614	+ 33.2
Dist. 4—Lower Gulf-S.W.	258.0	247.3	190.3	+ 35.6	29,646	22,107	+ 34.1
Dist. 5—East Central	51.8	48.8	30.6	+ 69.3	5,814	3,559	+ 63.4
Dist. 6—Northeast	394.5	381.0	343.1	+ 15.0	45,983	38,474	+ 19.5
Dist. 7-B—North Central	83.7	79.2	63.3	+132.2	9,543	7,504	+ 27.2
Dist. 7-C—West Central	99.4	91.9	53.0	+ 87.5	10,909	5,985	+ 82.3
Dist. 8—West	937.0	891.6	601.1	+ 55.9	106,222	68,666	+ 54.7
Dist. 9—North	150.6	147.5	130.8	+ 15.1	18,091	16,016	+ 13.0
Dist. 10—Panhandle	89.6	89.1	89.4	+ 0.2	10,758	10,810	— 0.5
Utah	3.4	3.6	3.4	.....	417	369	+ 13.0
Virginia	0.1	0.1	0.1	.....	8	8	.....
West Virginia	7.5	7.3	7.8	— 3.9	895	940	— 4.8
Wyoming	186.0	191.3	155.0	+ 20.0	22,756	18,776	+ 21.2
Total United States	6,138.7	6,039.9	4,968.4	+ 23.6	720,550	591,928	+ 21.7

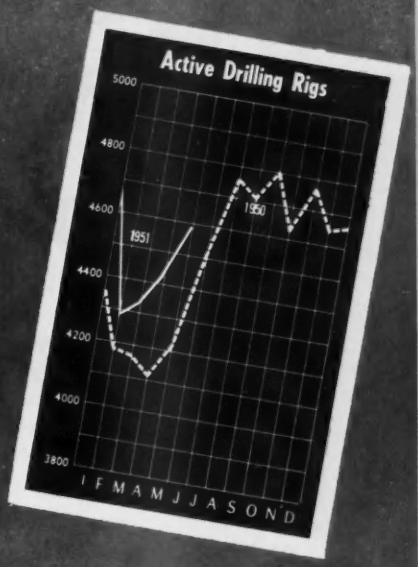
Trends in U. S.

WORLD OIL Staff









Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1949:											
April	5,012	5,141	272,520	2,494	125,351	846	51,231	1,147	59,668	398	593
May	4,972	5,195	273,912	2,585	121,602	813	57,442	1,138	63,576	409	572
June	4,903	5,162	274,691	2,597	114,041	771	64,730	1,041	64,628	400	598
July	4,704	5,173	267,586	2,613	111,217	835	71,553	1,040	66,084	428	624
August	4,780	5,241	260,585	2,593	104,879	902	76,037	1,078	66,843	413	614
September	4,940	5,427	251,689	2,617	101,799	1,002	83,213	1,110	67,117	374	623
October	4,997	5,373	250,932	2,643	103,287	1,001	90,643	1,141	68,673	492	785
November	5,210	5,293	256,010	2,594	104,707	962	88,212	1,180	65,112	435	703
December	5,024	5,475	253,356	2,633	111,521	1,032	75,207	1,208	60,193	485	828
1950:											
January	4,922	5,483	246,610	2,575	125,298	1,048	63,932	1,209	55,808	487	841
February	4,967	5,316	243,750	2,552	132,796	1,026	52,206	1,172	47,828	411	684
March	4,878	5,336	241,230	2,539	133,766	938	37,777	1,154	41,860	471	869
April	4,968	5,193	244,605	2,508	128,057	977	37,530	1,048	39,979	511	888
May	5,143	5,535	239,877	2,647	121,035	997	42,739	1,063	39,482	439	766
June	5,378	5,655	242,287	2,748	114,074	1,037	53,679	1,069	40,124	498	838
July	5,484	5,882	240,270	2,835	111,055	1,040	61,664	1,140	42,165	486	806
August	5,664	6,067	237,393	2,932	107,067	1,089	68,426	1,148	40,979	501	839
September	5,888	6,059	242,311	2,849	105,748	1,180	78,270	1,178	41,966	525	859
October	5,900	6,077	246,424	2,875	105,764	1,217	85,643	1,250	45,004	510	896
November	5,891	6,085	249,525	2,859	109,005	1,218	86,113	1,240	45,048	466	891
December	5,719	6,143	248,463	2,879	116,769	1,343	71,948	1,306	40,750	530	974
1951:											
January	5,907	6,450	243,107	2,962	128,479	1,427	58,424	1,368	40,317	499	977
February	5,930	6,562	235,247	2,906	137,243	1,419	47,587	1,382	39,409	468	937
March	6,040	6,398	235,956	2,901	142,186	1,307	43,170	1,354	37,282	544	944
April	6,139	6,187	242,635	2,814	136,986	1,238	44,255	1,254	36,084	509	906
April, 1951 Change:											
In Month	+99	—211	+6,679	—87	—5,200	—69	+1,085	—100	—1,198	—35	—38
In Year	+1,171	+994	—1,970	+306	+8,929	+261	+6,725	+206	—3,895	—2	+18
Week Ended:											
5-12-51	6,162	6,460	242,469	2,995	134,522	1,148	47,056	1,279	36,557	552	975
5-13-50	5,118	5,427	241,773	2,609	125,851	1,025	38,139	1,101	39,255	....	....

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JOBBERS IN ALL PRINCIPAL OIL FIELDS

Monthly News Analysis

Steel to Remain Scarce For Remainder of Year

Steel for oil industry use will continue scarce in the third and fourth quarters of 1951, despite operation of the new Controlled Materials Plan, for distribution of steel, copper, and aluminum. Steel supply will be especially tight in the third quarter but perhaps somewhat less so in the fourth. Some improvement in supply for all users is promised for early 1952.

CMP cannot perform the miracle of providing ample steel for the petroleum industry. But it is expected to produce a beneficial general effect, principally through holding to a minimum the supplies needed for manufacture of military goods and by causing more efficient distribution generally. Heretofore, substantial tonnage has been tied up for considerable periods, doing nobody any good, as bottlenecks in other materials and supplies have delayed actual use of steel delivered for defense production.

The Controlled Materials Plan is designed to assure adequate materials for defense production and to help provide sufficient supplies for defense-supporting or "essential" industries, including petroleum. However, the needs of all "essential" industries are very great, and every such industry has a government agency seeking steel for it in the same way the Department of Interior seeks steel for oil and gas, power, and mining industries. Farm equipment users are aided by Agriculture Department, for example, and railroads by Defense Transportation Administration.

Military Needs First

As conceived, CMP would fill military needs first, essential industry requirements second, employing priorities, and leave the remainder for consumer durable goods, which will not be covered by CMP. In practice, applications from virtually all the "essential" industries, including petroleum, seeking priorities for steel supplies, have been so high as to make it obvious that all such proposed purchases cannot and will not be fulfilled. Men connected with the government say that some of the defense-supporting industries are asking for much more materials than they have ever used before and evidently much more than they could possibly use. If such supplies were provided, it is added, there would be left for other purposes as little as in World War II, when there was no production of automobiles and appliances and no construction of new homes.

At present, no such disruption of the economy is contemplated. On the contrary, great efforts are being made to keep the whole economy as near normal as possible. It is indicated, therefore, that CMP probably will not greatly change the relative supplies of materials going to the "essential" industries and other users.

Factors promising to eventually improve the supply of steel include especially the high and still increasing steel mill capacity and the generally high inventories of steel and other materials held by manufacturers of durable goods.

Certain items of steel are scarcer than others and will remain so for some time. These include especially alloy steels, needed for military supplies, and structural shapes, required for new plants.

The Controlled Materials Plan is scheduled to go into operation July 1. Under this plan, the oil and gas industries have been allotted as their share for all operations outside the production branch during the third quarter, a total of only 963,000 tons. This is nearly one-third less than estimated requirements of about 1,400,000 tons. Actually, the industry may have difficulty securing even the amount allotted, especially in the case of the big item, steel plate, for steel tanks and pipe lines. The quota also must go into refining and marketing facilities, natural gasoline plants, secondary recovery projects, and other oil and gas operations.

While it set the 963,000-ton quota for other oil and gas industry operations, Defense Production Administration allotted for distribution through Petroleum Administration for Defense in the third quarter 450,000 tons of oil country tubular goods; and 180,000 tons of steel were set aside for allocation in the third quarter to 373 manufacturers of oil field machinery and equipment. It is PAD's opinion that the tubular goods quota will permit continuance of U. S. drilling at the desired minimum rate of 43,400 wells annually, but that the machinery and equipment quota is "very definitely a minimum figure."

Before the middle of May, National Production Authority had issued Regulations 1, 2, 3, and 4 applicable to the Controlled Materials Plan. Those regulations explained how CMP materials are authorized and obtained for manufacturing listed items, including oil country machinery, equipment, and tools; revealed how preference status for delivery of controlled materials is determined; prescribed limitations on inventories of manufacturers; and established rules for deliveries of steel, copper, and aluminum by warehouses, jobbers, dealers, and retailers. When these regulations were issued NPA began distributing from Washington and at field offices the forms needed by manufacturers to apply for third quarter allotments of controlled materials. Petroleum Administration for Defense will serve as claimant agency only for raw materials needed for oil well pumps, machinery, and tools. Refinery equipment and dispensing pumps will be handled by NPA's General Industrial Equipment Division. Most service station items will be under NPA's Motor Vehicle Division.

MRO Supplies

Not included under CMP are programs for MRO (maintenance, repair, and operating) supplies, which are handled through materials "set aside." Applications for these supplies in the oil and gas industries are handled by PAD under NPA's Order M-46. In late May, NPA was completing four new orders to replace the original Order M-46 upon initiation of CMP. Order M-46 (Amended) will continue authority of PAD to administer MRO, construction, tubular goods, and other materials programs. Order M-46-A will put PAD and Department of Commerce in charge of materials for foreign operations. Order M-46-B provides for applications for priorities on controlled materials for construction projects requiring $5000 or more of such materials. Order M-46-C provides for control of inventories.

Operators seeking priorities assistance in placing orders for drill pipe apply to PAD on Form PAD-17-DP.

This form combines an inventory report and an application for approval of either emergency or quarterly requirements. When approved by PAD, the form may be used as authorization for placing DO-48E (emergency) or DO-48 (normal operating) ratings on orders for drill pipe. Operators seeking priorities assistance in placing orders for casing or tubing apply to PAD on Forms PAD-15, 16 and 17. On approval by PAD they provide DO-48E or DO-48 ratings on orders for casing or tubing. Priority rating DO-48E, used since April 1, is approved by PAD only on orders for drill pipe, casing, or tubing used for wildcat drilling and emergency oil and gas well drilling purposes, such as meeting offset or drilling obligations. For filling these orders, 5 percent of tubular goods production is being set aside at warehouses in 13 cities around the nation. Rating DO-48 may be obtained, through PAD, effective July 1, to obtain drill pipe, casing, and tubing for normal operating purposes. Since March 15, oil and gas operators have had access to self-executed priority rating DO-97 in obtaining MRO supplies and laboratory equipment. PAD forms dealing with priorities may be obtained from oil field supply companies, trade association, state regulatory agencies, and Materials Division, Petroleum Administration for Defense, New Interior Building, Washington 25, D. C.

No Solution in Sight For Tidelands Tangle

Development of tidelands oil apparently is due to be stymied indefinitely, despite the urgent need for it. President Truman, who has sponsored the federal government "grab" of the tidelands and supported his position previously by vetoing a federal quitclaim bill, may again be the key figure responsible for delay of tidelands development. For it is assumed he would veto legislation that probably could be enacted, providing for "interim" development under administration by the states, pending final settlement of federal versus states controversy.

The Senate Interior Committee at middle of May voted 7 to 4 to approve for Senate consideration the substitution of ideas by Senator Long of Louisiana for those originally contained in S. J. Resolution 20, sponsored by Senator O'Mahoney of Wyoming, so as to give "interim" control over tidelands development to state agencies instead of the federal government, as proposed by O'Mahoney.

The amendments by Senator Long would validate existing oil leases on the tidelands, put in escrow all revenue from the areas collected by the states, permit Secretary of Interior to approve or disapprove new leases, and continue state administration over the submerged lands. O'Mahoney would have put control temporarily under Department of Interior.

Supporters of states' claims predicted that interim legislation embodying Long's amendments would be passed in both Senate and House. Even supporters of the Administration in Congress conceded that the amended resolution could be passed, but they forecast that it would be vetoed by President Truman. They said further that they were confident the veto could not be overridden.

All of this added up to the strong probability of a continued stalemate in tidelands controversy, indefinite delay of tidelands oil development, and losses for tidelands operators.

Price Order Involves No Major Change in Postings

Highest posted prices of January 25, 1951, for each producing pool in the U. S. were made the maximum legal prices by the Office of Price Stabilization, under its Ceiling Price Regulation 32, issued May 7.

This specific order governing crude prices involved no material change in control of crude prices, as covered by the general price control order of late January, but set up detailed provisions for administering regulations.

The new order provided methods, for example, to determine ceilings in cases where no posted prices existed on January 25. It permits applications for adjustments of ceilings in certain cases. It permits automatic increases in ceilings to offset increases since January 25 in taxes on production, severance, gathering, transporting, or processing of crude petroleum. But no provision is made for added transportation costs since January 25, making it necessary for the industry to absorb increased railway tank car charges recently authorized by the Interstate Commerce Commission.

This crude price order of May 7 was one of five specific oil orders issued by OPS up to that time.

Previously, Economic Stabilizer Eric Johnston, in a letter to Price Stabilizer DiSalle, laid out long-range pricing policies approved by Defense Mobilizer Wilson and the Defense Mobilization Board. Under the policy, the oil industry or any other industry is limited by established price ceilings but could seek industrywide increases by proving that dollar profits of the industry amount to less than 85 percent of the average for the industry's three best years of the period 1946-1949, inclusive. The profits must be figured before federal income and excess profits taxes and after normal depreciation only, with adjustments made for any changes in net worth. However, individual companies may seek relief, by showing hardship, or by proving that higher ceilings would overcome local shortage situations.

Private Line Not in ICC Domain, Says High Court

With only one dissenting vote, the U. S. Supreme Court May 7 held that the Interstate Commerce Commission does not have authority to regulate as a common carrier a privately owned refined oil products pipe line merely because it crosses state lines.

The ruling was made in the appeal of ICC from refusal of a three-judge lower court to enforce ICC's order directing Champlin Refining Company to publish and file schedules showing rates and charges for interstate transportation of refined petroleum products.

Congress did not intend, according to the opinion, that ICC should "make common carriers for hire out of private pipe lines whose services were unused, unsought after, and unneeded by independent producers, and whose presence fosters competition in markets heavily blanketed by large 'majors.'"

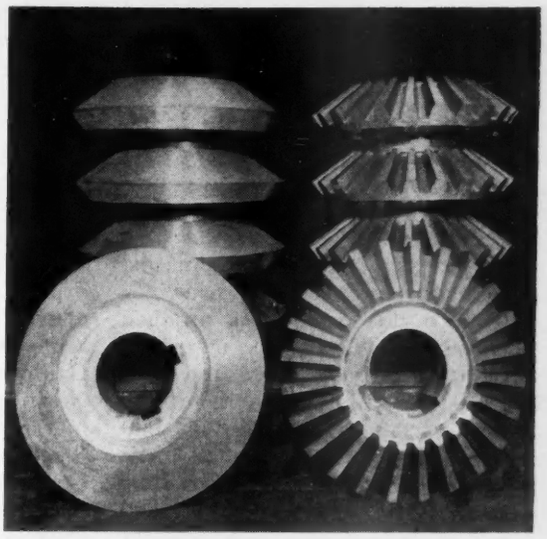
Under the decision, pipe lines carrying only the commodities of their owners from the owners' refineries to the owners' storage tanks for marketing are not required to serve as common carriers at rates regulated by ICC.

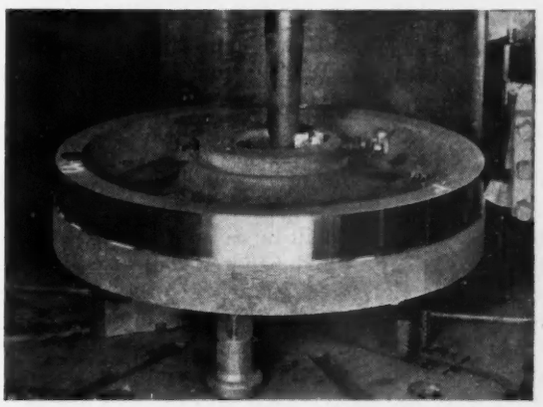
In the same case the Supreme Court upheld ICC, however, in requiring Champlin Refining Company to file annual, periodic, and special reports and to institute and maintain a uniform accounting system applicable to pipe lines. These matters were held to be independent from imposition of regulations and within ICC authority.

PAD Forecasts 5 Percent Demand Hike Early in '52

Required operations for meeting demand during 1951 and the first quarter of 1952 were forecast May 10 for National Petroleum Council by

MAY WE SPEAK OUR PIECE ABOUT Gear Blanks?





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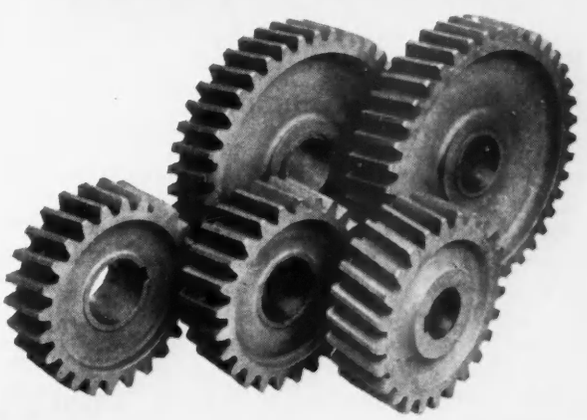

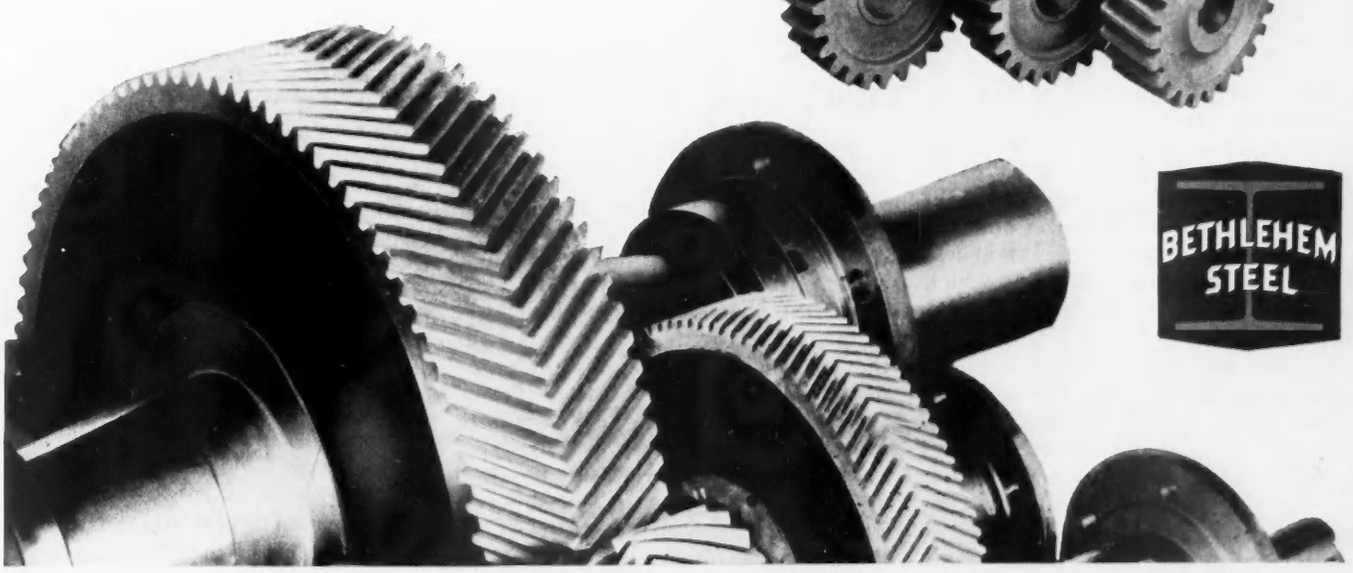

BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

Cecil L. Burrill, director of PAD's Program Division. PAD estimated quarterly demand up 5 percent in the first quarter of 1952 and annual total demand up 10 percent for 1951, including gains of 12.1 percent for gasoline, 9.4 percent for kerosine, 14.0 percent for distillate, and 7.8 percent for residual.

The industry can meet these needs, said Burrill, by operating near capacity. To do so it must produce 6,065,000 barrels per day of crude, 12.3 percent above 1950, with a peak of 6,160,000 daily in the third and fourth quarters. Imports of 950,000 barrels daily, or over 100,000 more than in 1950, will be required. Refinery runs must average 6,425,000 barrels daily and rise to a peak of 6,605,000 daily in the first quarter of 1952.

To avoid shortages, it will be necessary, also, stated Burrill, to fill all available storage this summer, including refinery tanks, primary and secondary terminals, and consumer tanks. By storing fuel oils this summer, seasonal strain on transportation and refining next winter will be held down, he pointed out. Furthermore, generally increased stocks are considered desirable in this critical period, and PAD would like to see as many days' supply of stocks on hand next March as at the end of the past winter.

Western Canadian Crude Now Priced to Compete

Western Canadian crude, now exceeding requirements of the Prairie provinces, has come into supply on a scale affecting its price. Need for more market has resulted in its price being lowered sufficiently to assure it an important outlet in Eastern Canada.

This competition of Western Canadian crude for markets in Eastern Canada was reflected in the lowering of prices of Alberta crudes by 29 to 44 cents a barrel in early May. It was believed that the reductions would permit delivery of the Canadian crudes in the Ontario market at less than costs of Texas crudes, which would consequently be priced out of that market. The new prices were not expected, however, to affect Ontario area imports of crudes from Oklahoma, Kansas, and Illinois.

The price reductions affected crudes produced in the Redwater, Turner Valley, Golden Spike, and Leduc Colmar fields.

Related to this bid of Alberta crude for a place in the Ontario market is the availability of economical transportation, following construction in 1950 of the Interprovincial Pipe Line to move western crude to the Great Lakes.

Western Canadian crude also is seeking an outlet to the west, in British Columbia and possibly the American Pacific Northwest. Several pipe lines to the Vancouver-Seattle area have been proposed in formal applications to the Canadian government. British Columbia currently offers a market of only about 40,000 barrels a day, which is being supplied from California. But the U. S. Pacific Northwest is a 200,000 barrel per day market, supplied by California and the U. S. Rocky Mountain area. Alberta crude probably could be laid down as far as Portland, Ore., as cheaply as at Sarnia in Eastern Canada, and on a basis permitting competition with California oil, despite greater transportation cost. It is reported that American and Canadian defense authorities are giving serious attention to the proposals for linking Western Canadian oil fields by pipe line to the Puget Sound and adjacent areas so as to assure that region an oil supply line less vulnerable than present tanker movements.

Adding to the problem of markets for increasing Western Canadian crude production is the prospect that this oil soon may be confronted with important new competition from the Williston Basin, following the recent discovery of oil in northwestern North Dakota. That discovery could be the forerunner of new fields in North Dakota, eastern Montana, southern Saskatchewan, and southwestern Manitoba. Such fields would be substantially closer than present Canadian fields to some of the present and potential markets for Western Canadian crude.

Gas Price Fixing Against Public Good, Says Murray

Regulation of natural gas production by the Federal Power Commission and fixing of either maximum or minimum wellhead prices would seriously hinder gas conservation and be against the public interest. This warning was convincingly sounded by William J. Murray, Jr., member of the Texas Railroad Commission, serving as witness for the State of Texas as intervener opposing FPC regulation of gas producers and gatherers. He was testifying at the FPC hearing at Bartlesville, Okla., to determine if Phillips Petroleum Company is a natural gas company under the Natural Gas Act. Murray testified at mid-May in the sixth week of the lengthy hearing.

As promoted by government, in the public interest, the fundamental purpose of conservation is to produce and utilize the greatest possible quantity of gas from each reservoir, declared Murray, and conservation of Texas gas would be seriously crippled by reduction of gas prices or imposition of utility-type restrictions on gas producers.

With benefit of improved prices of gas at Texas wells in recent years, the Texas Railroad Commission has been able to inaugurate important measures to conserve gas which were not feasible when the gas was less valuable, said Murray. He was referring to elimination of gas waste by prohibiting flaring and forcing construction of natural gasoline, cycling, pressure maintenance and related plants. These projects have been made economically possible by higher revenue from residue gas sold, as the natural gas liquids recovered from processed gas have not in themselves constituted profitable operations.

Murray opposed fixing of wellhead prices of gas, either maximum or minimum, as he felt prices would find the level that would be in the best interest of the public in a free market, through competition between different producers and buyers of gas and between the different fuels.

Many Texas gas producers have been reluctant to sell gas to an interstate pipe line company for fear FPC would regulate their prices and earnings, Murray pointed out. If such control were imposed, he said, it definitely would further restrict sales to interstate pipe lines and interfere with Texas conservation efforts.

Murray compared the FPC hearing with hearings frequently held by the Texas Railroad Commission and expressed hope that on the basis of information gained through the Bartlesville hearing, FPC would decide it should not assert jurisdiction over producers and gatherers. If FPC decided otherwise, however, and did impose such regulation, he added, there would be a definite conflict with the conservation program of the Texas Railroad Commission and it would be virtually impossible to carry out further conservation measures involving sale of gas into interstate pipe lines.

Any regulatory agency concerned with the long range welfare of the public must avoid any action that would necessitate waste of large quantities of gas in order to realize temporarily a small percentage reduction in the retail price of gas, Murray stated. This could result in exhaustion of supplies and a manifold increase in price in coming years, he declared.

G-406

This 1943 Article is even more important today!

THE OIL WEEKLY

August 9, 19

Accurate Depth Measurements Vital to Well Completions

The oil industry can no longer afford the luxury of careless depth measurements, with manpower and material at a premium. Accuracy and correlation of measurements must be maintained "from the grass roots down."

By A. C. H. COOKE
Division Engineer, Lane-Wells Company

MEASUREMENTS of distances on the surface of the earth have been developed into a fine art called "survey-

Seems a little like 1943, right now — similar demands for production, similar possibilities of manpower and material shortages. And with today's even greater demands and deeper wells, the best possible completions are even more vital now.

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Operators find this article so valuable that our reprint of it is still in print, eight years later. If you'd like a copy, write in, or

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Completions

Gain Over 1950 Period

DRILLING activity, after its customary drop in February, continued to mount during the following two months and by the end of March the number of wells completed this year held a substantial lead over those recorded in the same period of 1950. An even greater gain was accomplished in the total amount of footage drilled, which is a much better measurement of activity.

A total of 13,385 wells were finaled during the first four months of this year, for a gain of 636, or 5 percent, over the 12,749 drilled through March of last year. The footage drilled in those wells, which totaled 50,979,950 feet so far this year, showed a gain of 8 percent over the 47,191,718 penetrated during the same period of 1950.

In the first four months the Rocky Mountain Region showed the greatest percentage increase over the previous year's work, having upped the number of wells drilled 36.5 percent and total footage 37.2 percent. California was in second place with a gain of 28.5 percent in wells and 20.1 percent in footage.

Texas and New Mexico combined drilled 10.2 percent more wells and 11.3 percent more footage. In the Mid-Continent states, Oklahoma, Kansas, Missouri, and Nebraska, wells were 9.4 percent more numerous, while footage drilled totaled 14.6 percent more than it had a year earlier.

Ohio, Michigan, Illinois, Indiana, and Kentucky as a group saw completed wells drop 10.9 percent and the attending footage lowered by 5 percent. A decrease of 14.4 percent in wells and 13.2 in footage was the record of the Southeastern states, and for the Appalachian Region the score was down 10.3 percent in wells and 3.4 in footage.

Well Completions in the United States During April, and First Three Months, 1951

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from the *"Producers Monthly."*)

State or District	MONTHLY COMPLETIONS, APRIL, 1951									TOTAL COMPLETIONS				CUMULATIVE TOTALS January-April					Rigs in Operation (Drilling, Rigging-Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper												
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		April, 1951	Mar., 1951	April, 1950	Footage April, 1951	Wells 1951	Wells 1950	Percent Diff.	Footage, 1951	Footage, 1950	April 30, 1951	Mar. 31, 1951	April 30, 1950
Alabama	1			5				6	1	7	3	2	28,492	21	10	+110.0	95,727	33,496	3	9	4
Arizona											1			2			3,820				4
Arkansas	18			14				32		32	31	28	118,034	115	118	— 2.6	423,239	378,498	24	25	20
California	146		1	48				195	6	201	208	141	750,313	767	597	+ 28.5	2,879,785	2,397,783	229	220	225
Colorado	9		1	11				21	1	22	10	8	108,467	63	15	+320.0	304,025	55,593	24	26	11
Florida									1	1			1,684	1	6	— 83.3	1,684	41,116			3
Georgia															2	—100.0		9,075			
Idaho												2		1	3	— 66.7	12,844	8,540			2
Illinois	59			79				138		138	95	196	367,367	538	649	— 17.1	1,321,803	1,322,161	195	172	207
Indiana	24			58				82		82	92	89	154,444	316	388	— 18.6	558,953	681,595	167	190	180
Kansas	138		21	133			4	296		296	294	292	999,198	1,176	1,080	+ 8.9	3,972,222	3,526,263	433	366	292
Kentucky	28		20	38			1	87		87	71	90	159,961	315	285	+ 10.5	617,976	531,475	93	84	98
Louisiana	75	9	12	65				161	1	162	180	205	973,900	655	763	— 14.2	4,275,963	4,810,406	223	196	221
North Louisiana	43	1	10	39				93	1	94	105	103	358,667	335	380	— 11.9	1,244,634	1,409,924	75	62	57
South Louisiana	32	8	2	26				68		68	75	102	615,233	320	383	— 16.5	3,031,329	3,400,482	148	134	164
Maryland			1					1		1	3		3,488	7	1	+600.0	26,367	3,612	16	14	1
Michigan	15		2	36				53		53	65	54	123,408	204	233	— 12.5	507,710	575,863	120	95	138
Mississippi	7	3		9				19		19	27	36	132,921	84	124	— 32.3	581,693	924,592	36	26	29
Missouri			2	1				3		3		5	658	3	17	— 82.4	658	11,673	5	5	5
Montana	9			9				18	1	19	6	25	29,690	52	57	— 8.8	114,071	182,283	41	26	17
Nebraska	5		1	9				15		15	13	5	67,244	45	21	+114.3	200,735	84,099	12	13	2
Nevada														1			10,314		2	1	
New Mexico	40		13	21				74	1	75	39	53	348,110	217	199	+ 9.0	1,007,161	931,860	118	129	68
New York	26				19			45		45	42	41	64,361	159	216	— 26.4	224,079	304,538	70	71	76
North Carolina																					
North Dakota											1			1			5,609		2	2	
Ohio	25		10	26				61	2	63	71	68	109,803	261	279	— 6.5	531,764	614,436	119	123	138
Oklahoma	227	1	17	152	14		1	412	18	430	412	425	1,511,932	1,778	1,625	+ 9.4	6,387,931	5,597,625	590	575	540
Oregon																					
Pennsylvania	53		14	4	52	4		127	4	131	103	118	222,004	423	475	— 11.0	750,942	868,485	214	219	203
South Dakota															1	—100.0		5,710			
Tennessee															1	—100.0		1,430	6	6	8
Texas	861	13	63	551	7	1		1,496	24	1,520	1,537	1,266	6,586,704	5,745	5,212	+ 10.2	24,451,577	21,935,481	1,544	1,534	1,401
Dist. 1 S. Central	25		4	19				48	5	53	54	31	147,309	208	143	+ 45.5	545,259	414,840	38	43	29
Dist. 2 Middle Gulf	31		3	22				56	3	59	75	45	314,623	250	176	+ 42.0	1,391,280	1,015,003	55	56	59
Dist. 3 Upper Gulf	84	3	6	30				123	1	124	124	133	756,545	480	499	— 3.8	2,950,277	2,849,315	135	141	140
Dist. 4 L. Gulf-S.W.	64	3	8	50	3			128	2	130	148	136	643,986	522	524	— 0.4	2,627,006	2,455,576	119	124	122
Dist. 5 E. Central	15	2		11				28		28	56	13	142,893	152	52	+192.3	553,459	233,483	26	35	27
Dist. 6 Northeast	51	5	2	10				68		68	72	17	342,154	239	181	+ 32.0	1,190,580	855,782	34	34	33
Dist. 7-B N. Central	102		4	147				253	2	255	193	152	747,977	832	607	+ 37.1	2,364,803	1,849,557	173	185	142
Dist. 7-C W.Central	72			34				106	2	108	144	59	526,891	455	276	+ 64.9	1,932,363	1,148,768	146	145	78
Dist. 8 West	256			68				324	6	330	349	335	1,873,875	1,313	1,295	+ 1.4	7,106,598	6,905,792	498	463	470
Dist. 9 North	132		1	140	4	1		278	3	281	264	256	825,716	996	1,121	— 11.2	2,884,199	3,137,329	234	225	200
Dist. 10 Panhandle	29		35	20				84		84	58	89	264,735	298	338	— 11.8	905,753	1,070,036	86	83	101
Utah				3				3		3		1	13,776	8	7	+ 14.3	27,313	23,312	12	14	8
Virginia																			1	2	1
Washington												1			2	—100.0		16,032			
West Virginia	3		24	7				34		34	40	32	98,356	210	192	+ 9.4	604,770	463,005	195	200	275
Wyoming	33		4	18				55		55	68	40	252,546	217	171	+ 26.9	1,079,215	851,681	106	92	47
Total U. S.	1,802	26	206	1,297	92	5	6	3,434	60	3,494	3,412	3,223	13,236,861	13,385	12,749	+ 5.0	50,979,950	47,191,718	4,600	4,435	4,224

Industry Faces

Big Future Discovery Task

By WARREN L. BAKER, Editor

DESPITE STEPPED-UP wildcat drilling, the industry is discovering only a little more oil than before the war. This, in the face of rising demand, points to a problem of growing seriousness. WORLD OIL's editor sees the necessity for drilling 50,000 wells annually within five years and 57,000 within ten years. It follows that there has never been a more imperative need for the financial incentive embodied in the depletion allowance as it now stands.

IT IS becoming decidedly more difficult to find oil in the U. S., recent trends showing a steady decrease in volume discovered per discovery attempt. Large quantities of oil continue to be found only because of a greatly accelerated effort.

Doubling of wildcat drilling since the war has resulted in finding little more oil annually than before the war. Despite the expanded search, fewer barrels of oil are being found in relationship to consuming and producing rates. Meanwhile, stepped-up wildcatting has burdened the industry with twice as many dry holes annually, until failures now constitute more than one-third of all drilling operations.

A continuation of these trends forebodes trouble in the near future in keeping productivity abreast of skyrocketing consumption. With all signs indicating further sharp gains ahead in demand, it appears likely that the industry will need to enlarge drilling far above current peak rates in coming years to find enough oil to provide sufficient producing ability to fulfill requirements. Present trends presage a necessity for drilling 50,000 wells annually within five years and 57,000 wells within ten years. An even sharper growth in wildcatting is indicated, which surely would boost the number of dry holes drilled yearly.

The foregoing conclusions are based upon a projection of present consumption, producing, drilling and discovery trends. While projection of present trends may be risky, it can serve the useful purpose of portraying the broad outlines of problems which may arise in the future.

There is no indication that oil-using units have reached their peak in the U. S. In fact, they continue to grow at an accelerated pace, presaging further enlargement of oil consuming rates.

The number of motor vehicles (passenger cars, trucks and buses) registered in the U. S. reached an all-time peak of 48½ million at the end of 1950, nearly 4 million greater than a year previously and 17 million greater than at the end of World War II. Almost four times as many tractors were in use on farms at the end of 1950 as in 1935, and nearly double the quantity in 1945. The number of domestic home oil furnaces at the end of 1950 was double those in use at the end of the war and more than four times the number in operation in 1935. The most phenomenal growth in recent years, however, has occurred in railroad mainline diesel locomotives. The less than 800 mainline diesel locomotives in 1940 grew to 3800 by the close of 1945, then leaped to 13,900 in 1950.

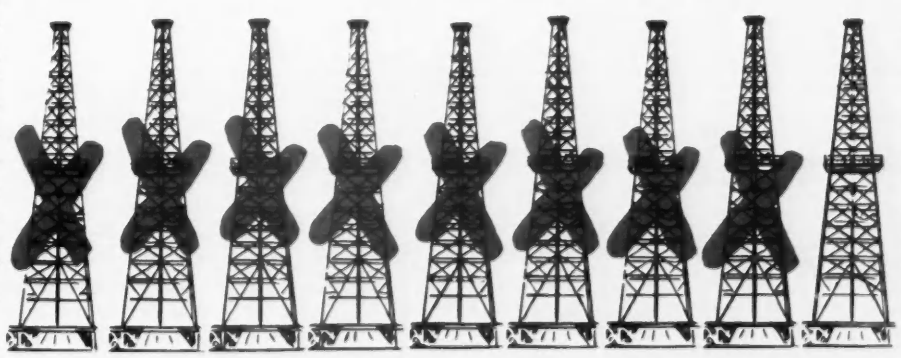
The growth in motor vehicles, oil burners, mainline diesel locomotives, and tractors was the greatest in history during the past year. This condition surely presages further growth. War might disrupt these trends, but according to World War II experience, military consumption would merely replace them in oil's demand picture.

U. S. use of petroleum has risen steadily, and the gain in each five-year period has been slightly greater than in the preceding five years. Growth of oil-using units indicates a continuation of this expansion trend. Consequently, demand for U. S. petroleum should reach at least 8,350,000 barrels daily by 1955 and attain a minimum level of 10 million barrels per day by 1960. This would be in contrast with the current record of 6,800,000 barrels reached in 1950.

Supply Possibilities

Prospective expansion of U. S. demand will provide ample room for enlargement of all sources of raw supplies: imports, domestic crude and natural gasoline production.

If U. S. domestic crude output continues growing at approximately the same rate as in the past, the nation would be producing 6,100,000 barrels per day by 1955 and 6,700,000 barrels daily by 1960; as compared with 5,405,000 barrels in



Only One of Nine Wildcats Is Successful

1950. This rate of growth would be only slightly less than during the five years between 1945 and 1950, although smaller than the rate of increase in earlier years. U. S. crude output increased 977,000 barrels per day during the five years ended with 1940, advanced 987,000 barrels daily by the end of 1945, and grew by an additional 711,000 barrels per day by 1950.

A production rate of 6,100,000 barrels per day by 1955 is extremely conservative, actually constituting a very small increase over current rates of about 6 million barrels daily during the early part of 1951. Nevertheless, this figure would represent a five-year gain equal to that of the last five years and is used in this study. Even at this rate, statistics trends indicate the industry faces a discovery task that will require sharply increased exploration and development efforts.

Even if the U. S. succeeds in boosting its crude production to the above amounts, demand will be sufficient to allow for further growth in U. S. natural gasoline output and for substantial gains in imports.

Assuming that natural gasoline advances from its 1950 rate of 496,000 barrels per day to 650,000 barrels daily by 1955 and then rises to 800,000 barrels by 1960, a sharp advance in imports will be required to satisfy indicated demand. Imports would have to reach 1,600,000 barrels per day by 1955, and 2,500,000 barrels daily by 1960, in contrast with 847,000 barrels per day in 1950. Failure of U. S. production to reach the levels indicated previously would require additional importation of foreign oil.

Chief supply question concerns the ability of the U. S. to continue expanding its producing rate by large volumes. There are growing indications that cast doubt on the ability of the nation to continue to find larger and larger quantities indefinitely. Among these are indications that it is becoming more difficult to find oil in this country, that postwar discovery rates have failed to keep abreast of producing levels, and recent expansion of discovery efforts without corresponding increases in volumes found. Nevertheless, for purpose of this study it is assumed that the U. S. will be capable of raising its productivity sufficiently to produce 6,100,000 barrels daily by 1955 and 6,700,000 barrels per day by 1960. Present trends indicate a mansize job confronts U. S. oil producers, and if they are to succeed in expanding U. S. producing ability to these levels they will have to expand drilling and discovery rates by very large amounts.

TABLE 1

U. S. Petroleum Demand and Supply Trends

(Barrels Daily)

	DEMAND		PETROLEUM SUPPLY					
	Total for All Oils		Imports		U. S. Natural Gasoline		U. S. Crude Production	
	Volume	5-Year Gain	Volume	5-Year Gain	Volume	5-Year Gain	Volume	5-Year Gain
1935	3,048,000	.....	144,000	.....	108,000	.....	2,730,000	.....
1940	3,981,000	933,000	229,000	85,000	152,000	44,000	3,707,000	977,000
1945	5,358,000	1,377,000	311,000	82,000	307,000	155,000	4,694,000	987,000
1950	6,803,000	1,445,000	847,000	536,000	496,000	189,000	5,405,000	711,000
1955 Est	8,350,000	1,550,000	1,600,000	753,000	650,000	154,000	6,100,000	695,000
1960 Est	10,000,000	1,650,000	2,500,000	900,000	800,000	150,000	6,700,000	600,000

TABLE 2

United States Oil Discovery Efficiency Rates

	CRUDE PRODUCTION	CRUDE RESERVES		NEW CRUDE PROVED UP DURING YEAR		
	Million Barrels Yearly	Million Barrels End of Year	Per Barrel Produced	Million Barrels Proved	Per Barrel Produced	Barrels Per Wildcat Completed
Pre-War:						
1937	1,279	15,507	12.1	3,722	2.9	1,705,755
1938	1,214	17,348	14.3	3,054	2.5	1,205,102
1939	1,265	18,483	14.6	2,399	1.9	873,634
1940	1,353	19,024	14.1	1,893	1.4	635,022
1941	1,402	19,589	13.9	1,969	1.4	577,589
Average	1,303	.....	....	2,607	2.0	947,388
Post-War:						
1946	1,733	20,874	12.1	2,658	1.5	626,591
1947	1,857	21,488	11.6	2,465	1.3	494,682
1948	2,016	23,280	11.6	3,975	2.0	620,125
1949	1,840	24,650	13.6	3,188	1.7	470,137
1950	1,973	25,268	12.8	2,563	1.3	329,307
Average	1,884	.....	....	2,970	1.6	491,705
Future Needs:						
1955	2,226	31,164	14.0	4,007	1.8	360,018
1960	2,457	34,398	14.0	4,423	1.8	300,027

TABLE 3

United States Oil Exploratory and Development Efforts

	TOTAL WELLS COMPLETED		WILDCATS COMPLETED		DRY HOLES COMPLETED		PERCENT OF TOTAL WELLS COMPLETED	
	Oil, Gas and Dry	Per Million Barrels Produced	Oil, Gas and Dry	Per Million Barrels Produced	Total Number	Per Million Barrels Produced	Wildcats	Dry Holes
Pre-War:								
1937	32,305	25.3	2,182	1.7	6,579	5.1	6.8	20.4
1938	27,764	22.9	2,443	2.0	6,515	5.4	8.8	23.5
1939	26,654	21.1	2,746	2.2	6,890	5.4	10.3	25.8
1940	29,161	21.6	2,981	2.2	7,053	5.2	10.2	24.2
1941	30,149	21.5	3,409	2.4	7,280	5.2	11.3	24.1
Post-War:								
1946	27,975	16.1	4,242	2.4	8,503	4.9	15.2	30.4
1947	31,084	16.7	4,983	2.7	9,751	5.3	16.0	31.4
1948	37,448	18.5	6,410	3.2	11,939	5.9	17.1	31.9
1949	37,812	20.6	6,781	3.7	12,898	7.0	17.9	34.1
1950	42,050	21.3	7,783	3.9	14,799	7.5	18.5	35.2
Future Needs:								
1955 Est	50,085	22.5	11,130	5.0	19,034	9.0	22.2	38.0
1960 Est	57,400	23.5	14,742	6.0	24,570	10.0	25.7	42.8

Larger Discovery Rate Needed

If U. S. production is to expand by substantial amounts in the future, there must be an immediate enlargement of discovery rates.

This country has continued to find large volumes of new oil each year. In fact, more new oil was proven in the 5 postwar years than in the 5 prewar years. Discoveries since the war have averaged 2,970,000,000 barrels yearly compared with 2,607,000,000 in the prewar period.

However, the larger volume found since the war has not maintained the industry's prewar ratio with producing rates. Before the war, an average of two barrels was found for every barrel produced, but postwar discoveries have averaged only 1.6 barrels per barrel produced.

In 1938, when 3 billion barrels of new oil were discovered, it was the equivalent to 2.5 barrels for every barrel produced during the year. However, in 1948, when the larger

volume of nearly 4 billion barrels were found, it was equal to only two barrels for every barrel produced because production had increased so sharply. In 1950 less new oil was discovered or proven than in 1938, and the ratio to production was only 1.3 barrels compared with 2.5 in 1938. These figures point to the increased need for finding substantially larger volumes of oil when production rises.

Experience shows that 1.8 barrels should be found for every barrel produced to maintain the country's reserve position. So if the U. S. is to be producing 6,100,000 barrels daily (2,226,000,000 barrels annually) by 1955, discovery rates must be increased sufficiently to average 4 billion barrels yearly by that time. If 1.8 barrels are to be found for every barrel likely to be produced in 1960, the discovery rate will have to be stepped up to almost 4½ billion barrels per year within ten years. Such large discovery rates never have been maintained in the past, so the job ahead is much greater than ever before.

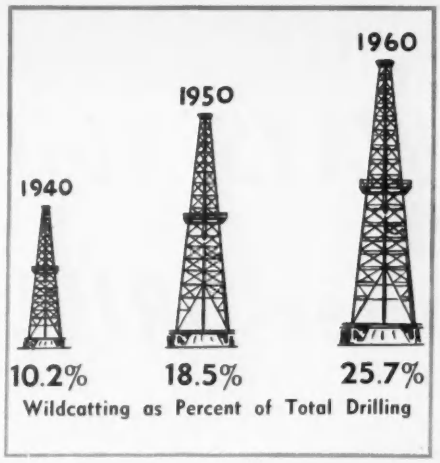
Reserves at New Peaks

Recent discovery rates have been sufficient to boost proved crude reserves to steadily higher peaks. Crude reserves have grown from 15½ billion barrels in 1937 to 19½ billion in 1941, to over 20¾ billion in 1946 and to 25¼ billion barrels in 1950.

However, as a result of finding fewer barrels in ratio to recent production rates, U. S. crude reserves at the end of 1950 were equivalent to only 12.8 barrels for every barrel produced during the year. Before the war it was normal for crude reserves to be equal to 14 barrels for the existing rate of production.

If the industry is again to maintain crude reserves at levels equal to 14 barrels per barrel produced annually, reserves must be increased to 31 billion barrels by 1955 and to 34⅓ billion barrels by 1960. This means the industry needs to discover 6 billion barrels more than it produces during the next five years — a tremendous task.

No one can know in any exact or even approximate sense what the discoveries of a year or even a month in advance may be; or whether there may be no more, one more, or a dozen deposits such as East Texas or Scurry waiting to be found. Present trends indicate that the discovery of another big oil reserve would certainly be a welcome event.



Wildcatting as Percent of Total Drilling

In view of the necessity of finding larger amounts of new oil than ever before, it is significant that it is becoming more difficult to find oil in the U. S. Fewer barrels of oil are being found per exploratory effort, and U. S. discovery rates are being maintained at large levels in recent years only through greater effort.

Although the amount of oil found each year includes that resulting from revision of previous estimates, extension and development of previously located fields as well as from new fields discovered, some measure of discovery efficiency can be obtained by comparing wildcat drilling with the number of barrels found annually.

Year by year the number of wildcats drilled has been growing at an amazing pace. The 7783 wildcats completed in 1950 were more than twice the 3409 completed in 1941, and almost double the 4242 drilled in 1946.

However, the amount of oil discovered has not kept abreast of the increased wildcatting campaign, and consequently fewer barrels of oil are being found per wildcat drilled than in the prewar era. Recent years have witnessed an almost steady decrease in oil found per wildcat drilled. Whereas 1¾ and 1¼ million barrels were proved for every wildcat completed in 1937 and 1938, respectively, this ratio declined to only ⅓ million barrels in 1950. During the five years immediately preceding the war, an average ratio of 947,000 barrels of new oil were found for every wildcat drilled. During the five postwar years, the amount of new oil discovered has been equal to slightly less than 500,000 barrels per wildcat drilled, or half the prewar ratio.

Thus it is evident that smaller amounts of oil are being found in recent years in relation to exploratory efforts, which emphasizes that it is becoming decidedly more difficult to find oil in the U. S. Actually, the nation's reserve position is being maintained only by a much greater drilling effort.

Larger Drilling Rate Needed

Declining discovery rates indicate that the U. S. must increase sharply its drilling rates in the future if enough oil is to be found to enlarge its producing ability sufficient to satisfy requirements in the years ahead.

The industry has stepped up its drilling rates to an all-time high since the war. Total wells completed in search of production during 1950 reached a peak of 42,000 in contrast with a prewar peak of 32,305 in 1937. Even at this rate, however, not as many wells were being drilled per million barrels produced as was completed in 1937 and 1938. The 42,000 wells completed in 1950 represent but 21.3 wells per million barrels produced during the year, whereas the 32,300 wells completed in 1937 constituted 25.3 wells per million barrels produced.

Should the discovery trends in Table 2 continue downward in the future, the country appears to be confronted with the necessity of increasing its drilling to at least 22.5 wells per million barrels produced by 1955. This would mean approximately 50,000 wells must be completed annu-

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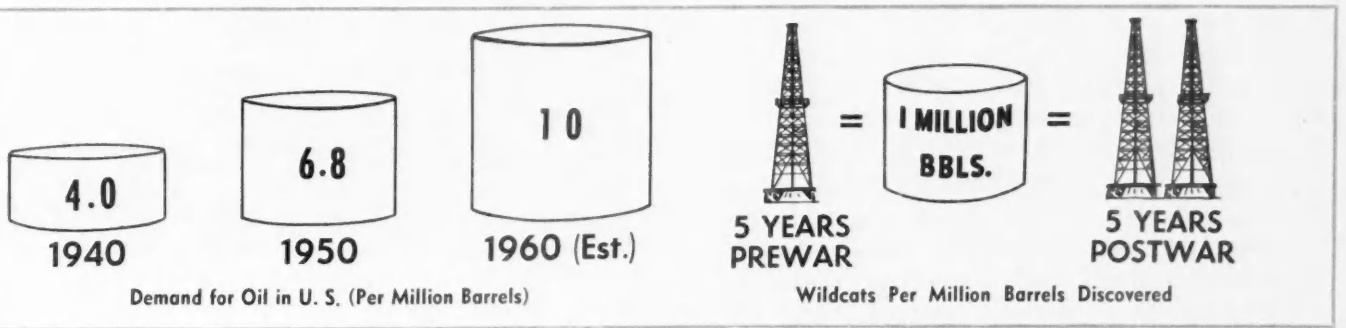


Demand for Oil in U. S. (Per Million Barrels)

Wildcats Per Million Barrels Discovered

4 WAYS YOU CAN lower DRILLING COSTS

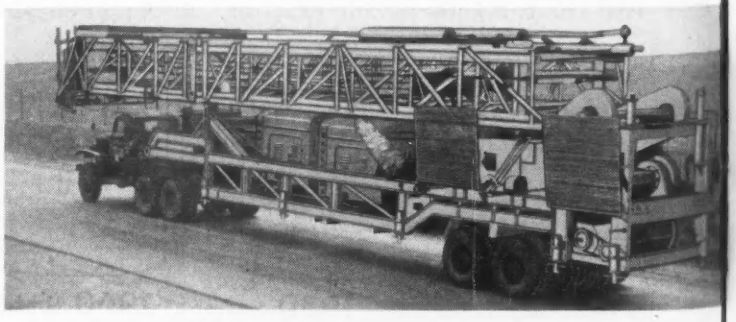
"We cover a lot of territory with our Cardwell 'Trailerig'," reports Curtis Singleton of Corpus Christi, Texas. "In a 90-day period, we drilled eight wells to an average depth of 4,000 feet, moving our 'Trailerig' a total of 600 miles between wells."

"We keep ahead of competition with low-cost moves," reports Big Six Drilling Company of Houston. "The total paid-out expense of moving our Cardwell 'Trailerig' five miles, including tear-down and rig-up time, has been as low as $300.00."

"Our customers like fast moves and fast drilling," reports S. H. Howell of Alice, Texas. "In a 30-month period, we drilled 350,000 feet of hole to an average depth of 5,400 feet."

"Low maintenance costs mean extra profits for any operator," reports McIntyre & Webster, Ltd., of Edmonton, Alberta. "After 24 months of continuous operation, the maintenance on our Cardwell 'Trailerig' is approximately 1% per year of the rig's cost."

In every way, this Cardwell "Trailerig" is a better buy. The "Trailerig" combines a full scale 5,000-foot, twin-engine, double-drum draw works including mud pump drive, with a 90-foot, 200,000-lb. mast (79,810 lbs. gross weight), or a 96-foot, 150,000-lb. mast (67,663 lbs. gross weight). All drives are equipped with Cardwell air friction clutches to provide fast, smooth control. Send for catalog and prices; or see your nearest Cardwell representative.



In roading position the "Trailerig" is only 8 feet wide, 13½ feet high and 59 feet long.

Company Operations Reflect Competition

By L. J. LOGAN, WORLD OIL Staff

COMPETITION and opportunity for private initiative are built into the American petroleum industry so freely, and with such obvious benefit to the public, that the industry appropriately can be cited as an outstanding example of the American competitive, free enterprise system.

Thousands of smaller companies and independent operators in 1950 accounted for about 42 percent of U. S. crude production, a higher percentage than in 1949. They operated about 71 percent of the producing oil wells, accounted for about 80 percent of total well completions, and drilled about 83 percent of the exploratory wells.

Independent refiners, including larger ones with integrated operations, accounted for about 16 percent of U. S. crude runs to stills.

Competing with each other as well as with the smaller operators were the larger or so-called major companies, which accounted for the remainder of industry operations. Together, they did a substantial part of U. S. oil producing, drilling, and refining. But there were more than a score of the major companies, each a rival of the other; and individually, even the largest companies accounted for only about 5 percent or less of U. S. crude production and about 10 percent or less of U. S. refinery runs.

The above is based on information compiled from annual reports of U. S. oil companies for 1950. The reports reflect a vigorous, progressive, and highly competitive industry, and show how each company fits into the gigantic business representing America's No. 1 industry, in terms of investment (not counting agriculture, railroads, and utilities).

These latest annual reports are themselves notably progressive, being generally attractive, interesting, and informative, as the companies carry the competitive spirit into their presentation and try to put out better reports than competitors.

Fortunately, there is a trend toward standardization of information and statistics in the reports, and it would be very desirable for a greater degree of standardization to be achieved, for the sake of better comparison of company operations and properties and better utilization of data for purposes of industry statistics. Especially is there need for more complete and uniform statistics on producing wells owned, acreage held, and wells drilled. Some companies include figures showing net (wholly owned and company's share in partially owned) wells and acreage, and it would be desirable for this to be done also by other companies, some of which show only gross (wholly owned and partially owned) wells and acreage. Most companies now include figures on both total and exploratory wells drilled and also break these down by productive and nonproductive wells. Industry statistics would be served if all companies would do this and do it on a uniform basis.

THIS ARTICLE reveals participation in 1950 in petroleum industry operations in the U. S. by the larger companies, individually and as a group, and by independent companies and operators, in the aggregate. The operations covered include crude production, producing wells operated, well completions, exploratory drilling, lease holdings, and refinery runs. The larger companies also are ranked in accompanying tables in the order of magnitude of their production, drilling, and refinery runs.

As brought together in the tables herewith, the information and statistics in the annual reports emphasize in several ways the highly competitive nature of the petroleum industry of the U. S. Only 60.85 percent of U. S. crude production was accounted for in 1950 by 35 companies that reported their output in annual reports for the year. These companies included not only the larger concerns but also a dozen smaller companies producing less than 25,000 barrels per day (or less than ½ of 1 percent of U. S. output) each and together accounting for only about 2.75 percent of U. S. output. Not counting output of the latter group, only about 58 percent of the country's crude production was accounted for by 23 larger companies producing over 25,000 barrels per day each, leaving about 42 percent (more than 2¼ million barrels daily) produced by the above dozen larger independent companies and thousands of other smaller concerns and operators. It has been estimated that there are about 18,000 independent operators engaged in drilling and production activities.

The largest producer of U. S. crude produced for its own account only 5.23 percent of the national total in 1950, and this was a decrease from the 5.47 percent it accounted for in 1949. This was Humble Oil & Refining Company, with net production averaging 282,501 barrels daily, compared with 275,900 daily in 1949. The Texas Company, with 4.78 percent of U. S. production, was No. 2 domestic producer, as Standard Oil Com-

pany of California dropped back to third place from second in 1949. Standard Oil Company (Indiana) improved its relative position, going from sixth into fourth place, as Gulf Oil Corporation dropped from fourth to fifth and Shell Oil Company from fifth to sixth. Socony-Vacuum Oil Company remained seventh. Continental Oil Company went slightly above Phillips Petroleum Company. Several other companies also underwent changes in relative position, including slight improvements for The Atlantic Refining Company, Plymouth Oil Company, and Lion Oil Company, at the expense of similar size companies, and a large gain by Sunray Oil Corporation, due mostly to its merger with Barnsdall Oil Company at the middle of 1950.

Competition was reflected not only by these changes among the larger companies but also by the performance of smaller companies, which as a group gained on the big companies in percentage of the nation's production. Among the top 23 producers, only five had a larger percentage of U. S. production in 1950 than in 1949, while 18 showed decreases. (The five that gained were Standard of Indiana, Socony-Vacuum, Continental, Sunray, and Richfield.) Among the dozen smaller companies in the list of 35 there were three that improved their percentages (Lion, Plymouth, and South Penn.). Production by companies for 1949 appeared in WORLD OIL, June, 1950, page 44.

While the largest domestic producer accounted for only a little over 5 percent of U. S. production in 1950, the percentages for the next six largest ranged between 3 and 5 percent. Virtually all other major producers rated only between 1 and 2 percent of U. S. output, with several showing between ½ and 1 percent. As indicated previously, the dozen smaller companies in the list herewith each had less than ½ of 1 percent of U. S. production.

Producing Wells

In the annual reports only a little more than one half of the 35 companies reporting on production showed the number of producing wells owned. The 19 companies that did so held at the end of 1950 a total of 82,587 producing wells, including at least 2500 gas wells and not more

Table 1. Domestic Crude Oil Production of U. S. Companies in 1950 and Wells and Acreage Held at End of Year
(Data from all available annual reports of U. S. companies)

	Net Domestic Crude Oil Production (Company's Net Share: Does Not Include Royalty and Co-owner Interests)			Wells Producing, End of Year (Net Wells Owned in U. S. Except as Indicated)			Acres of Leases and Fee Lands Held, End of Year (Net Acres in U. S. Except as Indicated)		
	Total Barrels	Barrels Daily	Percent of U. S.	Oil	Gas	Total	Producing (Developed or Operated)	Non-Producing (Undeveloped or Prospective)	Total Acreage
All Companies and Persons	1,971,845,000	5,402,315	100.00	467,776	.....	.....	.....	.....	.....
(1-A). Standard (N.J.) U.S. Affiliates, Total	124,830,000	342,000	6.33	.....	.....	.....	.....	.....	.....
1. Humble Oil & Refining Co.	103,113,000	282,501	5.23	.....	.....	10,294[19]	.....	13,500,000	13,500,000[25]
(1-B). Standard (N.J.) Net Share of U.S. Affiliates	95,958,500	262,900	4.87	.....	.....	.....	.....	.....	.....
72 Percent of Humble	74,241,500	203,401	3.77	.....	.....	.....	.....	.....	.....
100 Percent of Carter Oil Co	21,717,000	59,499	1.10	.....	.....	.....	.....	.....	.....
2. The Texas Company	94,249,359	258,217	4.78	.....	.....	.....	.....	9,735,390[24]	9,735,390[7]
3. Standard Oil Company of California	89,984,389[2]	246,533	4.56	.....	.....	6,498[6]	.....	.....	.....
4. Standard Oil Company (Indiana)	78,128,370	214,050	3.96	8,724	945	9,669	901,145[14]	11,228,410[14]	12,129,555[14]
5. Gulf Oil Corporation	74,635,000	204,479	3.79	.....	.....	.....	.....	9,900,000[7]	9,900,000[26]
6. Shell Oil Company	72,216,000	197,852	3.66	.....	.....	.....	.....	.....	.....
7. Socony-Vacuum Oil Company, Inc.	66,000,000	180,822	3.35	.....	.....	12,000[7]	.....	.....	.....
8. Continental Oil Company	36,875,585	101,029	1.87	.....	.....	.....	250,243	4,902,260	5,152,503
9. Phillips Petroleum Company	35,526,634	97,333	1.80	.....	.....	10,932[8]	841,451[13]	7,916,001[13]	8,757,452[13]
10. Sun Oil Company	31,994,000	87,655	1.62	.....	.....	.....	600,000[7]	5,500,000[7]	6,100,000[7]
11. Sinclair Oil Corporation	31,692,256	86,828	1.61	.....	.....	.....	246,336	6,708,239	6,954,575
12. Cities Service Company	30,627,000[2]	83,910	1.55	.....	.....	.....	.....	.....	7,100,000[7]
13. Atlantic Refining Company	30,286,000[3]	82,975	1.54	3,076	32	3,108	.....	.....	2,453,000
14. The Ohio Oil Company	30,242,497	82,856	1.53	7,236[10]	147[10]	7,383[10]	265,556	2,250,299	2,515,855
15. Tide Water Associated Oil Company	30,215,778	82,783	1.53	5,336	95	5,431	149,470	1,586,939	1,736,409
16. Union Oil Company of California	27,146,000	74,373	1.38	.....	.....	.....	.....	.....	.....
17. The Pure Oil Company	25,334,661	69,410	1.28	.....	.....	.....	.....	.....	.....
18. Sunray Oil Corporation	25,306,671[5]	69,333	1.28	.....	.....	3,237	168,915	1,287,381	1,456,296
19. Carter Oil Company	21,717,000	59,499	1.10	.....	.....	.....	.....	.....	.....
20. Skelly Oil Company	20,056,439[1]	54,949	1.02	3,014	349	3,363	284,383	2,936,743	3,221,126
21. Amerada Petroleum Corporation	19,121,209	52,387	0.97	1,941	136	2,077	.....	.....	5,197,000[15]
22. Richfield Oil Corporation	16,953,000	46,447	0.86	.....	.....	994	11,772	200,028	211,800
23. The Standard Oil Company (Ohio)	11,034,821[4]	30,232	0.56	.....	.....	2,484	91,206	806,770	897,976
24. Lion Oil Company	6,908,829	18,928	0.35	.....	.....	680	28,042	1,308,407	1,336,449
25. Mid-Continent Petroleum Corporation	6,591,644	18,059	0.33	1,961[9]	75[9]	2,036[9]	78,105[9]	1,342,520[9]	1,420,625[9]
26. Plymouth Oil Company	6,143,519	16,832	0.31	.....	.....	588	.....	.....	.....
27. United Gas Corporation	5,495,109	15,055	0.28	422[12]	642[12]	1,064[12]	.....	.....	1,706,415[16]
28. South Penn Oil Company	4,317,585	11,829	0.22	.....	.....	.....	.....	.....	.....
29. Houston Oil Company of Texas	4,103,956	11,244	0.21	.....	.....	.....	.....	.....	.....
30. Middle States Petroleum Corporation	3,376,122[4]	9,250	0.17	.....	.....	.....	.....	.....	.....
31. Deep Rock Oil Corporation	2,955,000	8,096	0.15	.....	.....	544[11]	31,213	373,518	404,731
32. General Crude Oil Company	2,833,858	7,764	0.14	.....	.....	.....	.....	.....	.....
33. Argo Oil Corporation	2,442,062	6,691	0.12	.....	.....	.....	.....	.....	.....
34. Panhandle Prod. & Refining Co.	1,431,299	3,921	0.07	.....	.....	.....	.....	.....	.....
35. Woodley Petroleum Company	803,885	2,202	0.04	.....	.....	205[17]	10,132[13]	85,890[18]	96,022[23]
Total 35 Companies	1,049,858,537	2,876,324	53.24	.....	.....	82,587[20]	3,957,969[21]	81,568,795[22]	101,982,179[27]
Royalty and Co-owner Oil Produced, Estimated	149,979,791	410,903	7.61	.....	.....	.....	.....	.....	.....
Gross Production, above Companies, Estimated	1,199,838,328	3,287,228	60.85	.....	.....	.....	.....	.....	.....
Rest of Industry	772,006,672	2,115,087	39.15	.....	.....	.....	.....	.....	.....
Total United States	1,971,845,000	5,402,315	100.00	467,776	.....	.....	.....	.....	.....

[1] Includes condensate. [2] Includes royalties received. [3] Includes LPG. [4] Includes other liquid hydrocarbons. [5] Includes former Barnsdall Oil Co.'s operations in first half of 1950. [6] Includes few in Canada, Venezuela, Colombia. [7] Not indicated if net or gross. [8] Gross wells; includes few in Venezuela, Canada. [9] Royalty or working interest. [10] Wells operated. In addition, Ohio had interest in other wells operated by others, as follows: 4,984 oil, 26 gas, 5,010 total. [11] Full interest wells. In addition, Deep Rock had part interest in 1564 other wells. [12] Wholly owned wells. In addition, United Gas partially owned other wells, as follows: 164 oil, 405 gas, 569 total. [13] Gross acreage in U. U. [14] Not indicated if net or gross; producing acreage includes 241,822 oil, 659,323 gas. [15] Full or part interest in leases, mineral rights, royalties. [16] Owned, leased, or covered by gas purchase contracts. [17] Wholly owned and operated: in addition, Woodley had 77 partnerships wells. [18] Lease and royalty acres. [19] Wells operated by Company. [20] Total for 19 Companies and subject to footnotes in this column. [21] Total for 15 Companies and subject to footnotes in this column. [22] Total for 18 Companies and subject to footnotes in this column. [23] Gross proved acreage and undeveloped lease and royalty acres. [24] Includes producing acreage. [25] Undeveloped acreage only. [26] Undeveloped acreage only and not indicated if net or gross. [27] Total for 22 companies and subject to footnotes in this column.

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226	6	3.3 x 4.4	226	80 @ 2400	182#' @ 1200	Clutch; SAE #3 or #4 housing; power take-off; Ford housing; 3-, 4- or 5-speed transmission; governor. (Available as closed or open type power unit, or engine assembly.)
239	V-8	3 3/16 x 3 3/4	239	85 @ 2400	187#' @ 1600	Clutch; SAE #3 or #4 housing; power take-off; Ford housing with 3-, 4- or 5-speed transmission; governor. (Available as closed or open type power unit, or engine assembly.)
254	6	3.5 x 4.4	254	95 @ 2400	212#' @ 1200	Clutch; SAE #3 or #4 housing; power take-off; Ford housing; 3-, 4- or 5-speed transmission; governor. (Available as closed or open type power unit, or engine assembly.)
337	V-8	3 1/2 x 4 3/8	337	117 @ 2400	257#' @ 1600	Clutch; 5-speed direct-in-fifth transmission; overdrive transmission, direct drive power take-off. (Available as closed or open type power unit, or engine assembly.)

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than 80,000 oil wells. In the U. S. there were about 468,000 oil wells and probably more than 75,000 gas wells. These 19 companies owned only about 17 percent of the oil wells in the country, while producing about 33 percent of the nation's crude output, having concentrated on flush production and left stripper production to independents. Assuming that other major companies similarly held about 1 percent of the nation's wells for each 2 percent of the nation's production, it may be estimated that the larger companies, together accounting for about 58 percent of U. S. production, did so through ownership of about 29 percent of the nation's oil wells. This would leave about 71 percent of the oil wells or nearly three fourths of the total as the property of smaller concerns and operators. Several of the large producing companies held around 10,000 to 12,000 wells each, and nearly all of the major companies held more than 2000 each.

Acreage Held

Figures on acreage of leases and fee lands were given by 22 companies, which together held more than 100 million acres of producing and prospective acreage. Only 15 companies showed producing acreage, which totaled about 4 million acres. Total undeveloped acreage for 18 companies was somewhat in excess of 80 million acres. Several of the larger companies held close to 1 million acres of producing or developed leases each and about ten times as much undeveloped acreage, or up to 10 to 12 million total acres each.

Only a dozen companies reported complete data on producing wells, producing acreage, and undeveloped acreage. But they represented a good cross-section of the industry, including large, middle-sized, and smaller companies and concerns operating in nearly all parts of the country. Those 12 companies held 46,958 producing wells, 2,861,390 producing acres, and 31,322,906 undeveloped acres, or a total of 34,184,296 acres. In the aggregate, they held, for each producing well owned, 61 producing acres and about 11 times as much prospective acreage (667 acres), a total of 728 acres. The 12 companies included in these figures are Standard of Indiana, Phillips, Ohio Oil, Tide Water, Sunray, Skelly, Richfield, Standard of Ohio, Lion, Mid-Continent, Deep Rock, and Woodley. Three companies, Standard of Indiana, Phillips, and Skelly, held acreage substantially exceeding these averages in relation to producing wells. Leaving them out, the other nine companies had 22,994 producing wells, 834,411 producing acres, 9,241,752 prospective acres, and 10,076,163 total acres, or on the average, for each producing well, roughly 40 producing acres and ten times as much prospective acreage (400 acres), or a total of 440 acres. These average lease holdings probably are quite representative or typical of the industry in areas of active development. (Data for Richfield indicate substantially lower than average lease holdings per producing well, reflecting relatively intensive development in California, where the company operates.)

The ratio of about ten times as much prospective acreage leased as the amount of producing acreage held possibly may be explained by the law of averages in wildcatting, as only one out of nine rank wildcats drilled is productive, on the average. The purpose of buying a 40-acre wildcat lease is to drill a wildcat on it and convert it to a producing lease; and under the law of averages, ten such tracts must be leased and drilled in order to accomplish the purpose.

Wells Drilled

As tabulated herewith, wells drilled, by companies, are closely related to crude production and producing wells of those companies. Humble, largest domestic producer and among the largest in ownership of producing wells, drilled the most wells. The Texas Company, second largest producer, drilled the second largest number of wells. Standard of Indiana, fourth in production and near the top in producing wells, was third in number of wells drilled. Besides Humble

Table 2. Number of Wells Completed in 1950 by U. S. Companies
(Data from all available annual reports of U. S. companies)

COMPANY AND RANK IN THIS LIST IN WELLS DRILLED IN U.S. IN 1950	SUMMARY OF WELLS DRILLED IN U.S. IN 1950		DETAILS OF ALL WELLS DRILLED IN 1950					
				PRODUCTIVE				
	Gross Wells	Net Wells	Class of Wells and Basis Reported	Oil	Gas	Total Prod.	Dry	Total Drilled
1. Humble Oil & Refining Co.	975	846	Gross wells drilled	....	....	....	....	975
			Net wells paid for	....	....	....	....	846
			Drilled by Humble, Total	....	....	669	147	816
			Exploratory	....	....	58	85	143
			Wildcats	....	....	18	....	....
			New Pay Tests	....	....	40	....	....
			Development	....	....	611	62	673
2. The Texas Co.	969[2]	.....	Total, Basis not shown	....	....	....	....	969
3. Standard Oil Co. (Indiana)	963	725	Gross wells drilled	690	143	833	130	963
			Exploratory	27	8	35	68	103
			Development	663	135	798	62	860
			Net wells drilled	532	100	632	93	725
4. Gulf Oil Corp.	861	....	Gross wells, U. S. and Foreign	....	....	....	....	1,032
			Gross wells in U. S.	....	....	704	157	861
			Exploratory	....	....	20	73	93
			Wildcats	....	....	11	55	66
			New Pay Tests	....	....	9	18	27
			Development	....	....	684	84	768
			Gross wells, Foreign	....	....	....	....	171
			Venezuela, Total	....	....	112	14	126
5. Cities Service Co.	....	506	Net wells (incl. few in Canada)	334	107	441	65	506
			Exploratory	8	3	11	30	41
			Development	326	104	430	35	465
6. Standard Oil Co. of Calif.	....	450	Net wells, U. S. and Foreign	....	....	421	....	....
			Net wells in U. S.	....	....	....	....	450
			Exploratory	....	....	11	34	45
			Development	....	....	....	....	405
7. Continental Oil Co.	632	442	Gross wells	....	....	....	....	632
			Net wells, Total	320	14	334	108	442
			Exploratory	24	4	28	60	88
			Development	296	10	306	48	354

Table Continued on Page 66

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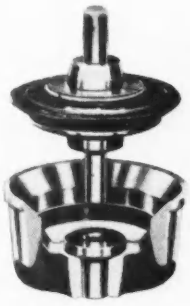

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Table 2—Continued

COMPANY AND RANK IN THIS LIST IN WELLS DRILLED IN U.S. IN 1950	[1]SUMMARY OF WELLS DRILLED IN U.S. IN 1950		DETAILS OF ALL WELLS DRILLED IN 1950					
				PRODUCTIVE				
	Gross Wells	Net Wells	[1]Class of Wells and Basis Reported	Oil	Gas	Total Prod.	Dry	Total Drilled
8. Sun Oil Co.	485	430	Gross wells	338	37	375	110	485
			Net wells, Total	....	....	....	....	430
			Exploratory	35	12	47	75	122
			Wildcats	6	....	6	....	....
			New Pay Tests	13	7	20	....	....
			Extensions	16	5	21	....	....
			Development	....	....	....	....	308
9. Phillips Pet. Co.	480	....	Gross wells drilled	361	69[3]	430	50	480
			Exploratory	8	3	11	23	34
			Development	353	66[3]	419	27	446
10. Shell Oil Co.	....	393[2]	Total, basis not shown	310	31	341	52	393
			Exploratory	....	....	52	28	80
			Development	....	....	289	24	313
11. Sinclair Oil Corp.	....	377	Net wells in U. S.	314	17	331	46	377
			Wells in Venezuela	1	....	1	1	2
12. Skelly Oil Co.	368	295	Net wells drilled	202	37	239	56	295
13. Atlantic Refining Co.	....	272	Net wells, U. S. and Foreign	230	28	258	68	326
			Net wells in U. S.	....	....	218	54	272
			Exploratory	....	....	10	31	41
			Development	....	....	208	23	231
			Net wells, Foreign	....	....	40	14	54
14. Sunray Oil Corp. (incl. Barnsdall)	385	244	Gross wells, total	....	....	321	64	385
			Exploratory	13	2	15	23	38
			Development	....	....	306	41	347
			Net wells, total	....	....	203	41	244
15. South Penn Oil Co.	....	201	Net wells, total	107	3	110	1	201[5]
			Exploratory	2	3	5	1	6
			Development	105	....	105	....	195[5]
16. Tide Water Associated Oil Co.	....	176	Net wells	147	10	157	19	176
17. Standard Oil Co. (Ohio)	281	160	Gross wells, total	....	....	197	84	281
			Exploratory	....	....	20	52	72
			Development	....	....	177	32	209
			Net wells, total	....	....	112	48	160
			Exploratory	....	....	14	31	45
			Development	....	....	98	17	115
18. The Ohio Oil Co.	250	....	Gross wells, total	183	15	198	52	250
			Exploratory	3	5	8	36	44
			Development	180	10	190	16	206
19. Amerada Petroleum Corp.	211	....	Gross wells	123	12	135	76	211
20. Mid-Continent Pet. Corp.	162	....	Gross wells, total	106	7[3]	113	39	162[6]
			Full Interest	82	7	89	26	124[7]
			Partnership	24	....	24	13	38[8]
			Exploratory	9	4	13	19	32
			Development	97	3	100	20	130[6]
21. Richfield Oil Corp.	....	140	Net wells, total	....	....	....	....	140
22. Union Oil Co. of Calif.	....	137[2]	Total, basis not shown	....	....	100	37	137
23. Lion Oil Co.	....	107	Net wells, total	92	1	93	14	107
24. Houston Oil Co. of Texas	144	72	Gross wells, total	....	....	....	....	144
			Exploratory	....	....	....	....	26
			Development	....	....	....	....	118
			Net wells, total	42	10	52	20	72
			Exploratory	....	....	....	....	13
			Development	....	....	....	....	59
25. United Gas Corp.	115	....	Gross wells, total	69	24	93	22	115
			Exploratory	1	3	4	3	7
			Development	68	21	89	19	108
			Drilled by self	69	16	85	20	105
			Drilled by others	....	8	8	2	10
26. Deep Rock Oil Corp.	....	54	Primary wells, net	30	5	35	19	54
			Exploratory	3	2	5	16	21
			Development	27	3	30	3	33
			Secondary wells, gross	....	....	....	....	88
27. Plymouth Oil Co.	78	48	Gross wells	....	....	66	12	78
			Net wells	....	....	41	7	48
28. Middle States Pet. Corp.	70[2]	....	Total, basis not shown	56	14	70	(?)	(?)
29. Argo Oil Corp.	40	....	Gross wells	....	....	31	9	40
30. Woodley Petroleum Co.	39	....	Gross wells	19	....	19	20	39
[13]Total, Above 30 Companies	10,321[9]	9,272[10]	[11]Net wells, 26 Companies	....	....	5,901	1,252	7,153
Percent of U. S.	....	21.5	Percent of U. S.	....	....	21.7	8.5	17.0
			[12]Exploratory wells, 17 companies	....	....	347	636	983
			Percent of U. S.	....	....	20.8	9.0	11.2
Total, U. S., new wells	....	43,176	New wells for oil or gas	....	....	27,244	14,778	42,022
			Exploratory wells	....	....	1,670	7,076	8,746

[1] Gross wells are all wells in which company held whole or part interest; net wells include wholly owned wells and only company's share in part interest wells. [2] Not shown if gross or net. [3] Includes 26 condensate wells. [4] Includes one condensate wells. [5] Includes 90 input wells. [6] Includes 10 service wells. [7] Includes nine service wells. [8] Includes one service well. [9] Includes only net wells for Cities Service, Standard of California, Sinclair, Atlantic, South Penn, Tide Water, Richfield, Lion, Deep Rock, and possibly net wells for Shell, Texas, Union of Calif. and Middle States [10] Includes gross wells for Gulf, Phillips, Ohio Oil, Amerada, Mid-Continent, United Gas, Argo and Woodley, and possibly gross wells for Texas, Shell, Union of Calif. and Middle States. [11] Total for 26 companies that showed completions productive and dry; and exploratory completions, productive and dry; excludes Texas, Standard of Calif., Sun and Richfield, because of incomplete data, and some wells are gross or possibly gross as stated in footnote 10. [12] Total for only 17 companies; Humble, Standard of Indiana, Gulf, Cities Service, Standard of Calif., Continental, Sun, Phillips, Shell, Atlantic, Sunray, South Penn, Standard of Ohio, Ohio Oil Co., Mid-Continent, United Gas, Deep Rock; and some wells are gross or possibly gross, as stated in footnote 10. [13] Companies that did not report data on wells completed, though reporting production, included Pure, Socony-Vacuum Carter, General Crude, Panhandle.

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and Texas, others that had exactly the same rating in drilling as in production included Phillips (No. 9), Sinclair (No. 11), and Atlantic (No. 13). Ratings in drilling and production were nearly the same also for Gulf, Continental, Sun, Tide Water, Amerada, Richfield, Lion, Plymouth, and United Gas. Standard of California and Union of California rated lower in the industry in drilling than in production, further reflecting California's relatively intensive development, prolific wells and leases, and possibility of drilling fewer wells in maintaining volume of production.

Just as the larger companies owned small numbers of producing wells in relation to their production, they also drilled small numbers of wells in relation to production, operating extensively in flush areas and to less extent in areas where wells are small and more wells are needed for a given volume of production. In their annual reports, 30 companies gave figures on wells they drilled in 1950. However, some of these gave only gross wells and not net wells, and therefore the total of 9272 wells obtained by adding net wells where possible and gross wells otherwise is at least several hundred wells higher than actually drilled. Net wells drilled by the 30 companies may be estimated roughly at not over 8500, and this is only about 19.8 percent of the 43,176 new wells drilled in the U. S. in 1950, although they produced 54 percent of U. S. crude output. These 30 companies included nine of the larger independent companies or smaller integrated concerns that drilled about 1.8 percent of the wells and produced about 2.2 percent of the oil. Leaving them out, 21 of the larger companies accounted for about 18 percent of completions and 51.9 percent of production. Three large companies that did not report completions (Socony-Vacuum, Carter, and Pure) accounted for about 6.5 percent of U. S. production, and on the basis of results for other larger concerns, may be estimated to have drilled about 2.3 percent of the wells. Adding them to the 21 other large companies, the total of 24 large companies drilled about 20.3 percent of the wells and produced about 58.4 percent of the oil. This left to the credit of the larger independents and all other smaller operators about 79.7 percent of total well completions and 41.6 percent of production.

Only 26 companies reported sufficient data to be included in totals for all completions broken down by productive and unproductive classifications. These 26 companies drilled 7153 wells (including some gross wells and therefore duplication) or 17.0 percent of 42,022 total new wells drilled for oil or gas in the U. S. in 1950. But their 5901 productive completions were 21.7 percent of the 27,244 for the whole industry, and their 1252 dry holes were only 8.5 percent of the 14,778 for the industry. Their success, better than for smaller companies and independents, probably reflected both better acreage for development and more technical advice.

In exploratory drilling, the larger companies were even farther above average in ratio of productive wells among those completed. Seventeen companies drilled 983 exploratory wells, which were 11.2 percent of the U. S. total of 8746. But they accounted for 347 productive exploratory wells or 20.8 percent of the total of 1670 in the U. S. and drilled only 636 dry holes or 9 percent of the total of 7076 for the U. S. For the previously cited 24 major companies that drilled about 20.3 percent of all wells and produced about 58.4 percent of the oil in 1950, there were evidently about 1450 exploratory wells completed, or about 16.6 percent of the 8746 total for the U. S. While they drilled a small number of total wells in relation to their production, they drilled exploratory wells in an even lower ratio. The remainder of the industry, consisting of independents, while accounting for 41.6 percent of U. S. production and drilling 79.7 percent of all U. S. wells, drilled therefore about 7300 exploratory wells or 83.4 percent of the U. S. total.

The independents apparently are now doing slightly higher percentages of both total drilling and exploratory drilling than they did in early postwar years, as revealed by tables showing well completions by companies in WORLD OIL, July 28, 1947, page 72, and *The Oil Weekly* (predecessor of WORLD OIL), February 10, 1947, page 126.

In addition to the wells they drilled or participated in drilling, some companies reported spending substantial amounts of "dry hole" money, contributing toward costs of wells drilled by others in exchange for resultant information bearing on value of leases held in the same areas. In this way, the larger companies contributed toward financing numerous wells drilled by independents, and to that extent the work of the latter was facilitated.

Since the larger companies account

Table 3. Domestic Refinery Runs of U. S. Companies in 1950
(Data from all available annual reports of U. S. companies)

COMPANY	CRUDE OIL RUNS TO STILLS AT U. S. PLANTS		
	Total Barrels	Barrels Daily	Percent of U.S.
(All Companies	2,094,867,000	5,739,362	100.00
(1-A). Standard (N.J.) U.S. Affiliates, Total	249,660,000	684,000	11.92
(1-B). Standard (N.J.) Net Share of U. S. Affiliates	226,971,975	621,841	10.83
72 Percent of Humble O. & R. Co.	58,340,880	159,838	2.78
100 Percent of Esso Standard and Carter	168,631,095	462,003	8.05
1. Socony-Vacuum Oil Co., Inc.	172,280,000	472,000	8.22
2. Standard Oil Co. (Indiana)	168,656,482	462,073	8.05
3. Esso Standard Oil Co. & Carter Oil Co. (Standard, N. J.)	168,631,095	462,003	8.05
4. Gulf Oil Corp.	163,657,000	448,375	7.81
5. *The Texas Co.	140,325,593	384,454	6.70
6. Shell Oil Co.	125,215,000	343,055	5.98
7. Sinclair Oil Corp.	110,797,331	303,554	5.29
8. Standard Oil Co. of Calif.	108,441,500	297,100	5.18
9. Humble Oil & Refining Co.	81,029,000	221,997	3.87
10. Cities Service Co.	76,854,000	210,559	3.67
11. Sun Oil Co.	63,432,577	173,788	3.03
12. Tide Water Associated Oil Co.	58,485,490	160,234	2.79
13. Atlantic Refining Co.	57,948,000	158,762	2.77
14. Phillips Petroleum Co.	56,969,792	156,082	2.72
15. Union Oil Co. of Calif.	43,461,000	119,071	2.07
16. Standard Oil Co. (Ohio)	39,721,517	108,826	1.90
17. Pure Oil Co.	39,627,323	108,568	1.89
18. Richfield Oil Corp.	35,391,000	96,962	1.69
19. Continental Oil Co.	29,758,085	81,529	1.42
20. Mid-Continent Petroleum Corp.	17,843,720	48,887	0.85
21. Skelly Oil Co.	14,560,904	39,893	0.70
22. The Ohio Oil Co.	13,034,382	35,711	0.62
23. †Plymouth Oil Co.	11,978,000	32,816	0.57
24. Sunray Oil Corp.	11,317,846	31,008	0.54
25. Lion Oil Co.	7,756,709	21,251	0.37
26. Deep Rock Oil Corp.	4,910,000	13,452	0.23
27. South Penn Oil Co.	2,932,775	8,035	0.14
28. Panhandle Producing & Refining Co.	1,771,829	4,854	0.08
Total 28 Companies	1,826,787,950	5,004,899	87.20
Rest of Industry	268,079,050	734,463	12.80
Total United States	2,094,867,000	5,739,362	100.00

* Runs held down by strikes at 5 plants lasting 7 to 17 weeks.

† Through wholly owned subsidiary, Republic Oil Refining Co.

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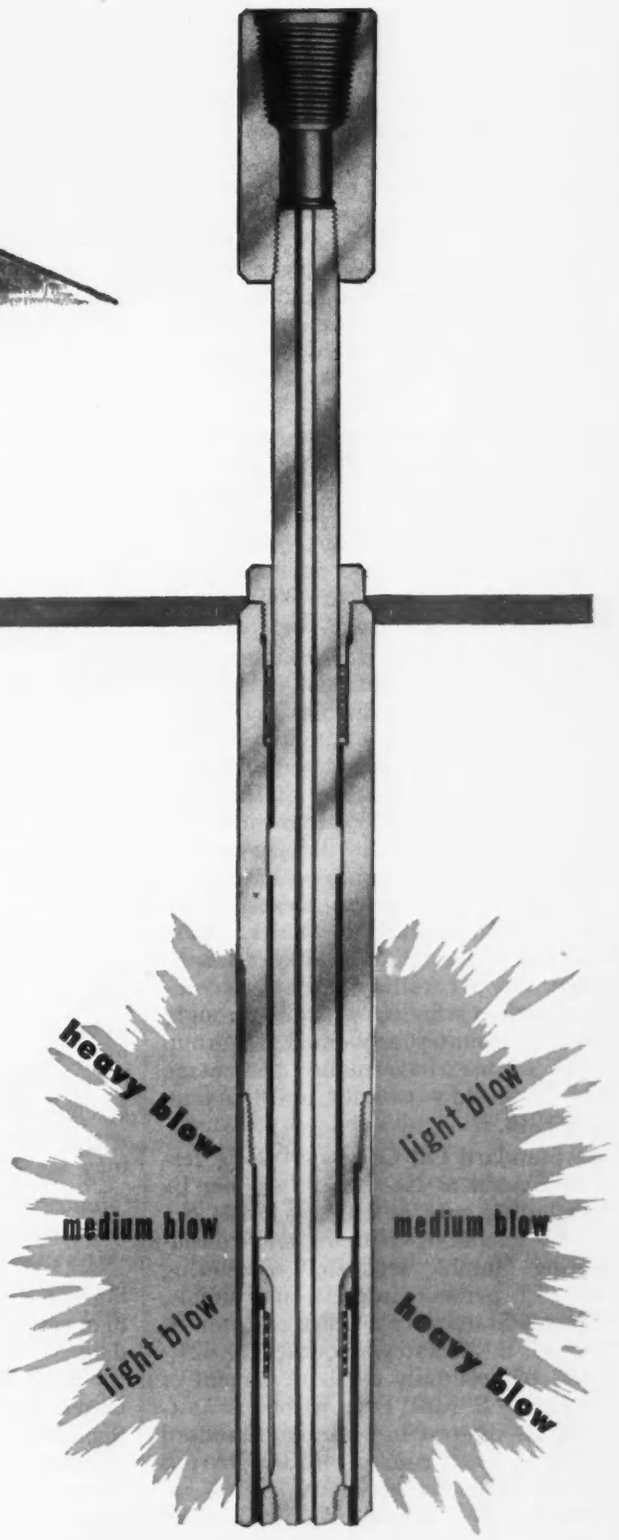

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for a high proportion of crude production while doing a low proportion of wildcatting and other drilling, it is evident that they achieve these results partly by purchasing and developing flush properties proved up by independent operators.

Refining Operations

Whereas production of petroleum is widely scattered and participated in by thousands of operators, refining is concentrated among fewer companies and areas. As shown in one of the tables herewith, 28 companies ran to stills in 1950 an average of 5,004,899 barrels of crude per day, or 87.2 percent of the total U. S. runs of 5,739,362 barrels daily; while the rest of the industry accounted for runs of 734,463 barrels daily or 12.8 percent of the U. S. total. Though all of the 28 listed companies are integrated concerns, the lower half dozen and another slightly higher in the list generally are considered independents rather than major companies, and together they accounted for runs of 160,303 barrels daily or 2.8 percent of U. S. runs. Taking these seven companies from the list leaves 21 major companies with runs of 4,844,596 barrels daily or 84.4 percent of the U. S. total. This leaves for the seven smaller integrated companies and all other independent refiners combined runs of 894,766 barrels daily or 15.6 percent of U. S. runs.

There were very few changes from 1949 in relative positions of the different refining companies in the industry. However, a majority of the larger companies accounted for somewhat higher percentages of U. S. refinery runs in 1950 than in 1949 (WORLD OIL, June, 1950, page 44); those that failed to do so having included Socony-Vacuum, Texas, Standard of California, Tide Water, Union of California, Pure, and Mid-Continent. As a corollary, the smaller, independent refiners, operating throughout the country, accounted as a group for a somewhat smaller percentage of U. S. runs to stills in 1950 than in 1949.

Standard Oil Company (New Jersey) rated as No. 1 U. S. refiner by including runs of Humble or as No. 3 by excluding Humble and considering Humble separately. Counting its 72 percent interest in Humble, Jersey Standard's net share in runs of its U. S. affiliates amounted to 621,841 barrels daily or 10.83 percent of total U. S. runs. Even without counting its interest in Humble, Standard (N. J.) with runs of 462,003 barrels daily or 8.05 percent of the U. S. total, was only slightly outranked by Socony-Vacuum and Standard of Indiana. Gulf's runs of 448,375 barrels daily were 7.81 percent of the industry total. Next in order among the 10 largest domestic refiners came Texas, Shell, and Sinclair, with runs between 300,000 and 400,000 barrels daily, or about 5 to 7 percent of the U. S., and Standard of California, Humble, and Cities Service, with runs of 200,000 to 300,000 daily, equivalent to about 3½ to 5 percent of the U. S. total. Runs of 100,000 to 200,000 barrels daily, or roughly 2 to 3 percent of the U. S., were reported by Sun, Tide Water, Atlantic, Phillips, Union of California, Standard of Ohio, and Pure.

Industry Faces Big Future Discovery Task

■ CONTINUED FROM PAGE 57

ally on the basis of producing 6,100,000 barrels daily.

The need to increase the ratio of drilling to production likely will continue. If it reaches the neighborhood of 23.5 wells per million barrels by 1960, then U. S. drilling must be stepped up to around 57,000 wells yearly if production reaches 6,700,000 barrels per day.

Even with these rates in total wells completed, a much sharper increase in wildcat drilling seems to be indicated. In 1950, nearly four wildcats were completed for every million barrels produced, the highest ratio in history. The prewar peak was in 1941, when only 2.4 wildcats were completed for every million barrels produced during the year.

Declining discovery trends presage the need for continuing this upward trend in wildcat drilling. Consequently, needs may range somewhere in the neighborhood of five wildcats per million barrels produced in 1955, which would mean the completion of approximately 11,000 wildcats per year by that time. Further upward progress in this trend may result in six wildcats being completed for every million barrels produced by 1960, or the annual completion of something like 14,700 wildcats per year.

Failures Increase

The growth in number of dry holes completed by the industry has boosted the number of failures drilled per million barrels produced. There were 7½ dry holes completed for every million barrels produced in 1950, in contrast with a little more than five dry holes per million barrels produced in prewar times. This increase in dry holes is likely to continue since larger numbers of wildcats cannot be drilled without a corresponding gain in failures. Present trends indicate there may be nine dry holes drilled for every million barrels of production, or approximately 19,000 per year within five years. Ten years hence may see around ten dry holes completed for every million barrels produced, or 24,500 dry holes annually. In contrast, the current peak is represented by the 14,799 dry holes completed in 1950.

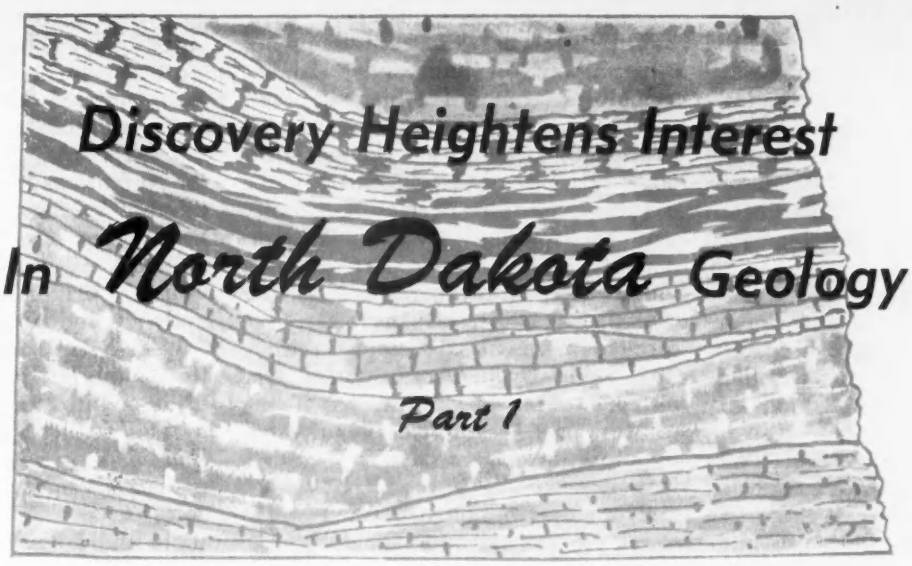
Thus, it is indicated that more and more of the industry's drilling will be made up of wildcats and dry holes.

Wildcat drilling has steadily comprised an increasing portion of total drilling activity. Of all the wells completed, 18.5 percent were wildcats in 1950 compared with only 15.2 percent in 1946, with 11.3 percent in 1941, and with but 6.8 percent in 1937. A continuation of these trends would see wildcats accounting for about 22 percent of all drilling by 1955 and 26 percent by 1960.

Dry hole operations accounted for only 20 percent of all drilling in 1937, but steady growth boosted this to 30 percent by 1946 and to 35 percent by 1950. Dry holes undoubtedly will constitute a larger portion of the drilling in the future. Recent rates of growth indicate approximately 43 percent of all wells may be failures by 1960.

Prospects that it will be necessary to drill a larger number of wells, including more wildcats and dry holes, confronts the industry with a terrific financial burden. There has never been a more imperative need for increasing the incentives for oil exploration and development. Consequently, there is a greater need than ever before the 27½ percent depletion allowance and the right to expense intangible drilling and development costs. Furthermore, the present need unquestionably is not anywhere near as great as it will be in the near future.

The figures presented here may be in the realm of strict speculation. However, they represent the projection of present trends, and there is no better way to judge the future than by past experience rates. Therefore, they should serve to point out the broad outline of the magnitude of the oil discovery task that lies ahead. It is likely to be truly gigantic.



By DR. WILSON M. LAIRD

State Geologist, North Dakota Geological Survey, University of North Dakota, Grand Forks

OIL IN NORTH DAKOTA was the encouraging word flashed around the state when Amerada Petroleum Corporation made a highly significant strike with Clarence Iverson 1 in SW SW 6-155n-95w, Williams County, further stimulating the already high interest in the state's geology. The well is considered North Dakota's first commercial oil discovery although it had not been completed as a producing well. The last test, before preparations to drill deeper were made, yielded 451 barrels of 53.4-gravity oil with 3.9 million cubic feet of gas in 16 hours through one-half-inch choke. At last report, drillers were trying to recover a lost bit from the hole before drilling deeper to evaluate lower horizons. Meantime, other locations have been rumored in this and nearby areas.

Putting even more emphasis on oil possibilities of this rarely explored state, are current reports of oil shows in a wildcat being drilled 155 miles southeast of Amerada's discovery. Although information is being closely held, several shows of oil have been reported from Phillips Petroleum Company and The Carter Oil Company's Patented 1, in NE NW 29-136n-81w, Morton County.

The Amerada producer was tested in what is believed to be beds of Devonian age, although there is some doubt as to the exact position in the Devonian. After drilling to 11,744 feet, casing was set and tubing run. Several tests were made near the bottom of the hole with some recovery before the zone 11,630-60 feet was perforated and acidized with a total of 10,000 gallons. It is through those perforations that production tests were made. The well was originally scheduled as a 10,000-foot basement test, and it was believed that Amerada intends to go to basement rocks in this venture before plugging back to the proven producing level.

A little more than a mile south of the discovery, a location for a test was announced by M. B. Rudman and Critchell Parsons of Dallas. This wildcat will probe Ordovician beds as well as the Devonian zone found by Amerada.

OIL PRODUCERS, influenced by successes in Western Canada, are taking a closer look at areas where similar conditions might be encountered. In North Dakota this interest is evidenced in large concentrations of leases taken during the past several years. It is obvious, from the present article, that the conditions necessary for oil accumulation (source rock, reservoir rock, and traps) are present in North Dakota. However, the main difficulty seems to be finding all three conditions suitable in one place. The writer is optimistic that such conditions can be encountered if enough wells are drilled.

The Phillips and Carter operation was reported drilling below 6490 feet toward a 9000-foot objective, and was said to have recovered oil on a test at the 5800-foot level. Another drill-stem test at about 6170 feet was also reported to have recovered 45-gravity oil.

Another encouraging show of oil was reported in Souris Valley Petroleum Company's J. H. Downey 1, in lsd. 11, Sect. 9, TWP. 1 n., R. 27 WPM., Province of Manitoba, Canada, just a few miles across the border from North Dakota. This show was logged in the Madison of Mississippian age. As will be noted below, Standard Oil Company of California's Daly 15-18 in lsd. 15, Sect. 18, TWP 10n., R. 27 W.P.M. has produced some oil from the Madison formation also. These wells, while not in North Dakota, are significant in that they are close to the state and the same geologic conditions which they indicate in Manitoba will almost of a certainty be found in North Dakota.

One pertinent reason why there is so much interest is that in the western part of the state is an extensive basin where approximately 14,000 feet of sedimentary rocks have been deposited. Several of these formations have been petroliferous in other parts of the U. S. and Canada, and there seems to be no reason why they should not be oil-bearing in North Dakota.

During 1950, four wells were drilled in North Dakota, all dry holes.

Because so few wells have been drilled in North Dakota, there is too little known concerning the subsurface stratigraphy of the state, particularly the Paleozoic. These rocks are known only from about 17 wells in the state proper and from the surface outcrops of the formations in Manitoba, Montana, and the Black Hills of South Dakota.

In view of the fact that the state consists of more than 70,000 square miles and that there have been only about 17 wells drilled, not all of these penetrating the entire sedimentary section, all present conclusions in regard to the stratigraphy of the Paleozoic particularly, must be regarded as tentative. Undoubtedly there will be many changes of opinion as more wells are drilled.

Structure of State

The general structure of North Dakota is that of a large basin called the Williston Basin. This is a general area of downsinking which apparently was active from Ordovician time up to and including the later part of the Tertiary. This basin of downsinking is one of several on the shelf area of the main geosynclinal trough which is now the present site of the Rocky Mountains in the U. S. and Canada. This basin is of interest because it has not always been in identically the same spot. During various periods it has migrated slightly, but in general its location is that outlined on the structure map, Figure 1, showing the contours drawn on the top of the Dakota sandstone.

On this general feature there are superimposed a number of smaller structures, some of which are still fairly large. One of these (the Nesson Anticline) is the largest known anticline in the state. It is located in the northern part of McKenzie County and the southern part of Williams County. It has been reported that a number of seismic highs are located on this main trend; however, the present writer has seen no seismic map which would confirm this. Another structure of some size is in the central part of Emmons County extending into Logan and McIntosh counties.

Numerous minor structures are in other parts of the state. There is some question, however, whether these are due to diastrophic movements or whether they might be compaction features. In either event they are of interest because they do show small amounts of closure.

From the standpoint of suitable traps for oil accumulation, it is the writer's opinion that most attention must be placed on stratigraphic type traps. In North Dakota the varieties of this type which are most likely to be found are unconformities, reefs, and various types of wedge-out conditions. Therefore, proper knowledge and interpretation of the stratigraphy is vital.

Stratigraphy

GENERAL: In general it can be said that all formations in North Dakota thin eastward out of the basin (Figure 2). They also thin to the southeast and northeast. Toward the west, however, they tend to thicken, but some thin shortly after passing into Montana. The relationships of the formations in North Dakota with those of Western Canada are not entirely clear. This is due to a lack of information, and as soon as more wells are drilled, the relationship will undoubtedly become clearer.

CAMBRIAN: So far as is known, the Cambrian extends only a short distance into the state. The only well in which there is positive evidence that it is present is Carter N. P. 1 in Fallon County, Montana. There it consists of ". . . interbedded green shale and dolomite overlying a basal glauconitic sandstone."[1] Some observers would place it also in a number of other wells in the state but no general agreement on this has been reached.

ORDOVICIAN: The Ordovician is one of the most extensive of the Paleozoic formations in the state. It is known in practically every well drilled deep enough to encounter it. In general it can be divided into three formations. These are, from the bottom up, the Winnipeg, Red River, and Stony Mountain. The exact age of these particular formations in terms of the standard section is not exactly known; but probably the Red River and Stony Mountain formations are Upper Ordovician, and the Winnipeg formation may be approximately equivalent to the Chazy. The Winnipeg is from 100 to 535 feet thick and consists largely of gray-green shale, some sandstone, sandy limestone, and gray sandstone.

In some wells, notably that of the E. L. Semling well in Oliver County, North Dakota, the Winnipeg is rather largely shale with relatively little sandstone. However, in the Northern Ordinance Franklin Investment Company 1 in Emmons County, North Dakota, there is a considerable sand section present which has excellent porosity. When this well was drilled, it was found that the sandstone carried abundant water under considerable pressure. This water was relatively fresh, having an analysis of 2607 parts per million total dissolved solids, but there might be some question here if some drilling water rather than formation water were not tested. This sandstone, if found under proper conditions, would make an excellent reservoir rock. Overlying the Winnipeg formation is the Red River formation consisting largely of gray to tan, dense to granular, dolomitic, and sandy limestones. These limestones

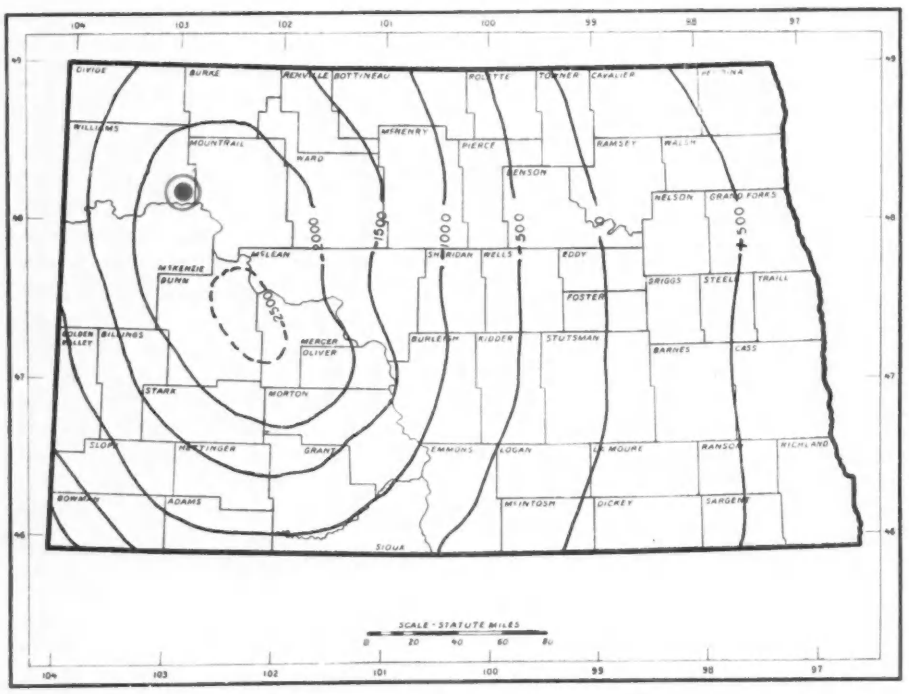


FIGURE 1. Structure map of the Dakota sandstone based on sea level datum. Amerada Petroleum Corporation's Williams County Wildcat discovery is circled in green.

frequently have in them zones of porosity which are of considerable interest although as yet no oil has been found in them. Overlying this is the Stony Mountain formation, from 100 to 500 feet thick, consisting of white dolomitic limestones and shale. On the outcrop in Manitoba this formation consists more of red and green shales and interbedded limestone.

SILURIAN: It was thought for some time that the Silurian was not present extensively except in the northern part of the state. However, reexamination of the cuttings from some of the deeper wells revealed that the Silurian probably is more extensive than was formerly thought. It is dense white dolomitic limestone with relatively little or no porosity in the wells that have been drilled to date. However, on the outcrop in Manitoba there are frequently biostromes in this formation, and also probably reefs of coral and associated organisms.

DEVONIAN: The Devonian in North Dakota is of considerable interest at the present time in view of the fact that it is one of the main petroliferous formations in the province of Alberta, Canada, and also, oil has been encountered in it in North Dakota, as stated earlier in this report. The Devonian in North Dakota apparently is most closely correlative with the surface outcrops of the Middle Devonian in Manitoba. In the latter locality the Devonian is apparently largely if not entirely Middle Devonian in age. Starting at the bottom, it consists of the Ashern formation which in North Dakota is estimated to be from 0 to 117 feet in thickness. It consists rather largely of red and variegated shales with some limestone. Some geologists place this unit in the Silurian; others classify it as Siluro-Devonian.

Overlying the Ashern is the Elm Point limestone, a rather thin formation totaling from 0 to 60 feet in thickness. It consists rather largely of a dense, mottled limestone which sometimes has a slightly saccharoidal texture.

The Winnipegosan formation overlies the Elm Point and varies from 0 to 660 feet in thickness. This is chiefly a dense to saccharoidal dolomite. It frequently has excellent porosity and unquestionably in some places reef-like beds have been encountered in this formation both at the surface and in the subsurface. Certainly at the outcrop, reefs have been found in this particular formation in southwestern Manitoba.

Manitoban Formation

Overlying the Winnipegosan formation is the Manitoban formation, which consists of buff and slightly pinkish, mottled limestone, some dolomite and anhydrite and varies from 0 to 250 feet in thickness. In the basal part of the section in the outcrop in Manitoba, the Manitoban sometimes has a red shale, dolomite and limestone interval.

The Manitoban is overlain by the Lyleton formation which has been named by Allan and Kerr.[2] It consists of calcareous red shales and some dolomites with a little sand and is 0 to 190 feet in thickness. This formation is regarded as probably being Upper Devonian in age.

As has been indicated, all the formations with the exception of the Lyleton are regarded Middle Devonian in age. It would appear, however, that in the western part of the state may be formations which are very similar in lithology to the Upper Devonian of Montana. In this part of the state the Devonian formations below the Lyleton consist of beds of dense to saccharoidal dark brown limestone and saccharoidal dolomites. Porosity of both a vugular and intergranular nature are present. These rocks, as has been indicated before, apparently are very close in their appearance lithologically to the Upper Devonian in Montana and may be the rough equivalents of the Potlatch interval of Montana. However, no positive fossil remains have yet been identified to place these rocks exactly in their proper stratigraphic position. Considerable amounts of salt and anhydrite also have been found associated with these beds. Whether or not the salt and anhydrite beds belong in the Devonian or in the underlying Silurian is as yet an unsolved problem. This age problem of the Devonian in North Dakota is an extremely interesting one, inasmuch as somewhere in the state probably the Upper Devonian overlies the Middle Devonian and, therefore, a wedge-out zone is possible within the state.

So far as is known to the writer, no beds of reef-like nature have as yet been encountered in beds which might be classified as Upper Devonian. However, Middle Devonian reef beds have been reported in several wells.

MISSISSIPPIAN: The Mississippian is also of great interest in view of the fact that shows have been found in beds of this age, notably the upper part of the Madison limestone. In general the Mississippian can be divided into several major groups. These are the Englewood or Kinder-

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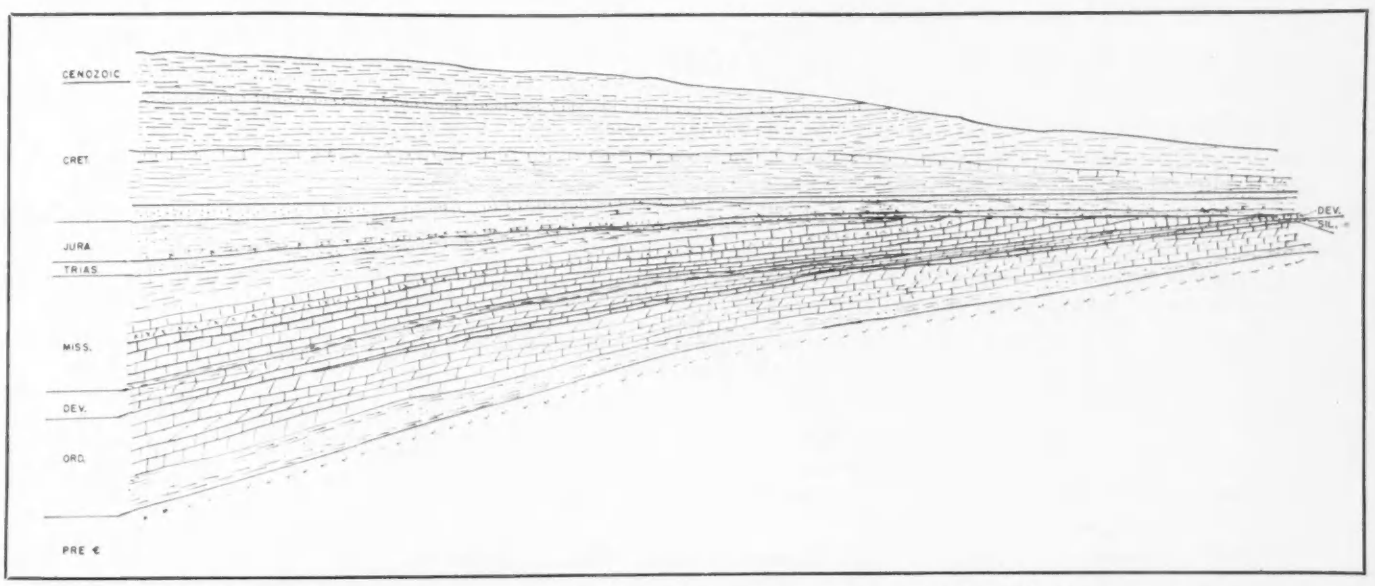
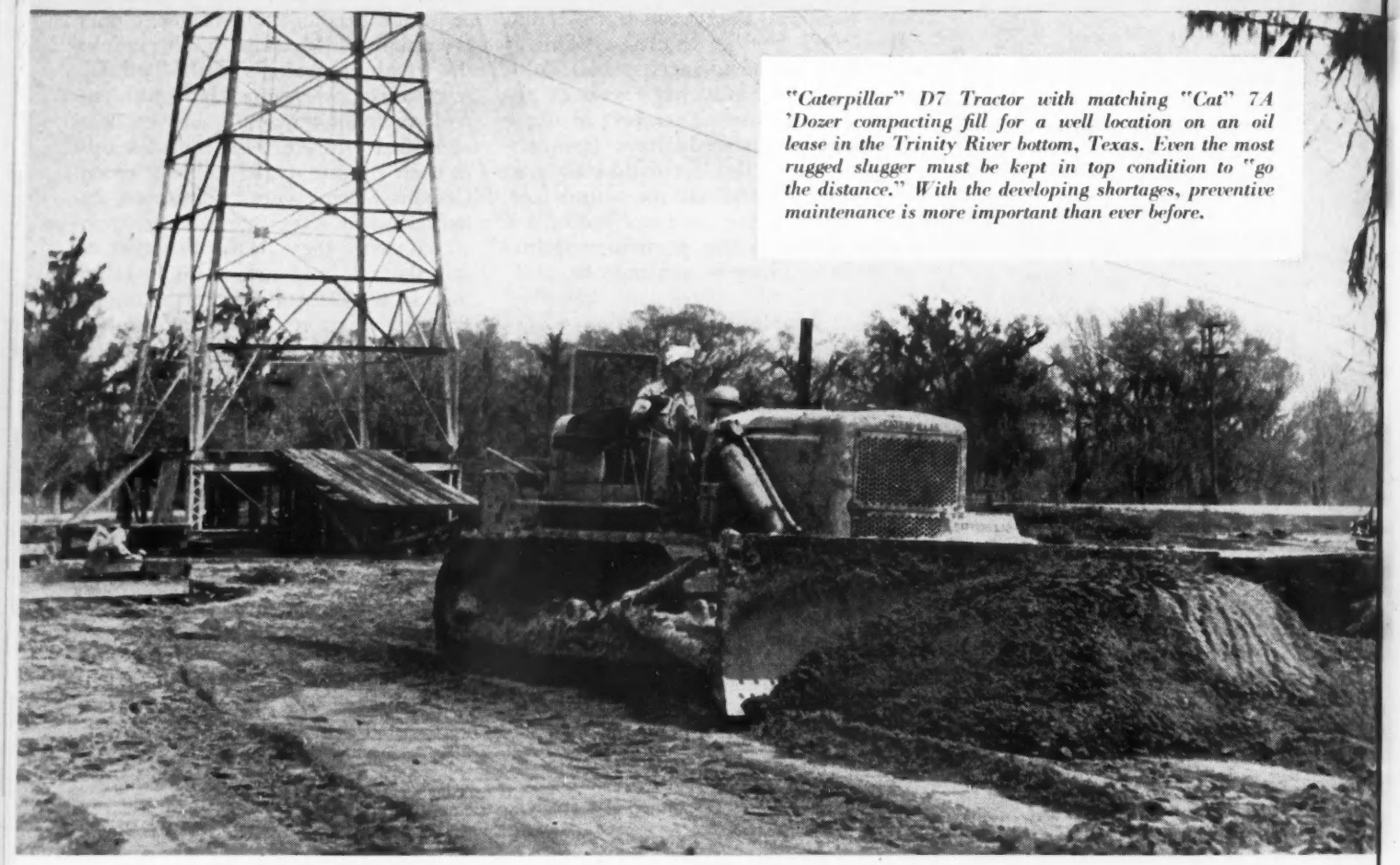


FIGURE 2. Diagrammatic east-west cross-section across North Dakota, based on the top of the Dakota sandstone.

There's a big



"Caterpillar" D7 Tractor with matching "Cat" 7A 'Dozer compacting fill for a well location on an oil lease in the Trinity River bottom, Texas. Even the most rugged slugger must be kept in top condition to "go the distance." With the developing shortages, preventive maintenance is more important than ever before.

IF YOU WANT TO HELP YOUR COUNTRY— AND YOURSELF AT THE SAME TIME— READ EVERY WORD ON THESE TWO PAGES

Keeping equipment *on the job* is of prime importance today—to the nation as well as the oil industry. Making hole, laying pipe—it's a big, vital job that's getting bigger and more essential than ever as the nation builds its military strength. This year calls for 45,000 producing wells —171 *million* feet of hole. Seven million barrels a day are needed to power industry and the military machine.

Right now there is a shortage of material with which to build urgently needed machines and parts. Military and Defense Rated Orders get the nod over unclassified civilian needs. Steel and other materials are in short supply. This means that you—with our help—must get every last machine-power hour out of the equipment and parts you now have.

Down-time will not only weaken the defense effort, it can put the operator himself behind the eight ball. In order to meet the double demands of the civilian and military oil market, he must put greater demands on the machines he uses to bring the oil in. The time has come when he must rely more and more on preventive maintenance to keep his equipment on the job.

So to stay in business profitably, and help America arm for defense, do these things now:

1. Use equipment properly. "Cat" machines are built for hard use—not abuse.
2. Give *extra* attention *now* to preventive maintenance (see next page).
3. Discuss your parts needs and maintenance problems with your "Caterpillar" dealer. His maintenance responsibility begins where your operators' and mechanics' responsibility ends. He has the skilled servicemen and equipment to rework and rebuild worn parts to keep your machines on the job longer.

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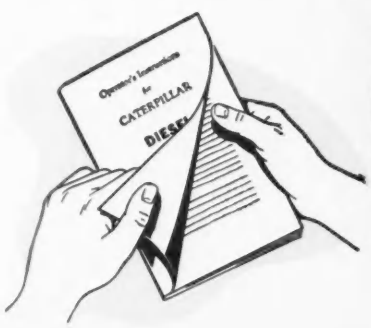
The last war showed the Military that "Cat" Earthmoving Equipment was as important to defense and offense as tanks. Here Sgt. Robert Chrisman operates a "Cat" D7 Tractor with matching blade on Davison airstrip at Ft. Belvoir, Va.

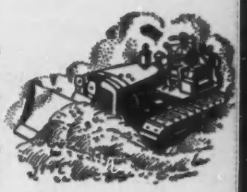
job ahead!

You're the Doctor

Today no owner can afford to think of direct costs alone. Good care of equipment can mean the difference between a producing machine and one laid up for repairs. To see how good care can save many hours of equipment life, reread your Operator's Instruction Book often and follow these suggestions.

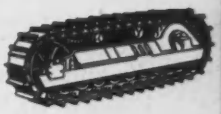


• DUST



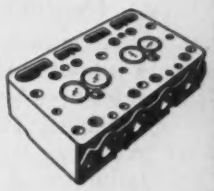
Think of dust as Machine Enemy No. 1. A few grains today—a few more tomorrow—and soon the result adds up to serious wear. Dust or dirt plugged breathers or air cleaners—use of dirty oil containers—loose intake manifolds—loose inspection covers—dirty clutch compartment—failure to wash flywheel clutch compartment—worn seals on crankshaft—defective gaskets—failure to clean oil filter openings . . . these are some of the vulnerable spots.

• TRACK ASSEMBLY



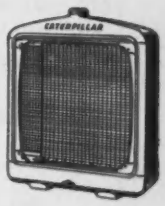
Don't let abusive use or neglect cripple the service life of your track assembly. Track adjustment and lubrication of rollers, carrier rollers and idlers are your job. Before excessive wear occurs on grousers, links, pins, bushings, idlers, rollers and sprockets, call in your "Caterpillar" dealer. He can build up grousers, rollers, idlers and links, and replace sprocket rims and turn pins and bushings so you will have many additional hours of service.

• CYLINDER HEADS



Prevent cracked cylinder heads by avoiding overheating, freezing, scale deposits, filling a hot engine with cold water, pulling heads down too tight, and other poor maintenance practices. Your "Caterpillar" dealer can repair most cracked cylinder heads. He can replace worn valve seats with valve inserts and restore the rocker arm mechanism to serviceable limits. Consult your Operator's Instruction Book for proper cooling system and valve care.

• COOLING



Don't let your engine overheat. Keep the cooling system free of scale, rust and sediment. Use soft or treated water, and when freezing temperatures exist, protect your engine with anti-freeze. Clean the radiator regularly with chemical flushing solutions. Remove foreign matter from the core by brushing or washing. Prevent engine troubles which come with overheating. Consult your Operator's Instruction Book for proper cooling system care.

• LUBRICATION

Careful lubrication practices will add much to your satisfaction through equipment performance, economy and long life. Use *only* recommended lubricants, changing the lubricant at proper intervals. And use *only* "Caterpillar"-proved filter elements. Remove dirt from fittings and clean around the crankcase filler cap before adding oil. A little care saves many hours of engine life. Consult the lubrication chart in your Operator's Instruction Book.

• PISTONS AND LINERS

Almost all the piston wear occurs in the upper ring groove. Your "Caterpillar" dealer can renew your pistons by machining the upper ring groove for a wide ring, many sizes of which are chrome plated. Worn liners can be deglazed and put back to work for many additional hours of service life. Consult your Operator's Instruction Book for information on lubrication and the oil cooling system.

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Gravity Exploration for Reefs And Other Porosity Maxima

By H. KLAUS and J. C. HUGHES
Klaus Exploration Company, Lubbock, Texas

FOR the purpose of this article, a reef is considered as merely a special case of a porosity maximum. Other well-defined porosity maxima are also included in the discussion. It goes without saying that a porosity maximum in reservoir rocks, in potential oil country, is of prime interest to the oil producer. Since variations in porosity bear a definite and decisive relationship to the bulk density of rocks, it is evident that gravity work can contribute very substantially to the exploration work necessary to find features of this type.

GRAVITY WORK can play an important role in exploration for porosity maxima, including reefs, sand lenses, shoe string sands, etc. Variations in porosity bear a definite and decisive relationship to the bulk density of rocks. While attention has been focused on reefs through spectacular Canadian and West Texas discoveries, other types of porosity maxima may again be of great importance.

Definitions and Requirements

A porosity maximum is defined as a porous rock mass surrounded on all sides by a less porous, or non-porous, envelope. This definition includes all reefs, as well as sand lenses, shoe string sands, and other porosity maxima which might be of interest to the oil industry. The definition given above avoids the difficulty of proof whether or not a porosity maximum in limestones or dolomites should be classed as a reef, from a purely geological standpoint.

In order to produce measurable gravity effects, porosity maxima must fulfill the following requirements:

- The changes in porosity must be relatively fast, and large enough to produce appreciable density contrasts;
- The resulting density boundary zones must have attitudes involving relatively large vertical components;
- The total anomalous mass must be large enough so that its gravity effects exceed decisively the probable error of the gravimetric method used.

Foremost among the geologic bodies meeting these requirements are the larger reefs. With respect to the last requirement, gravity work as we know it today acts as a selective tool, singling out the larger and more porous reef masses, and suppressing the smaller and less porous ones. This aspect of gravity exploration for reefs cannot be stressed strongly enough, since it offers to the geologist and to the seismologist an effective way to high-grade their reef prospects. Other porosity maxima are the following:

- Sand lenses in shale;
- Shoe string sands in shale;
- Locally less cemented sandstones in tight, well cemented, massive sandstones;
- Locally dolomitized areas in massive limestones (for instance, Michigan);
- Locally leached areas in dolomites and limestones (for instance, Central Kansas Uplift);
- Extensive local fracture zones, or brecciated zones, in normally tight formations; and
- Truncated horsts or grabens, in

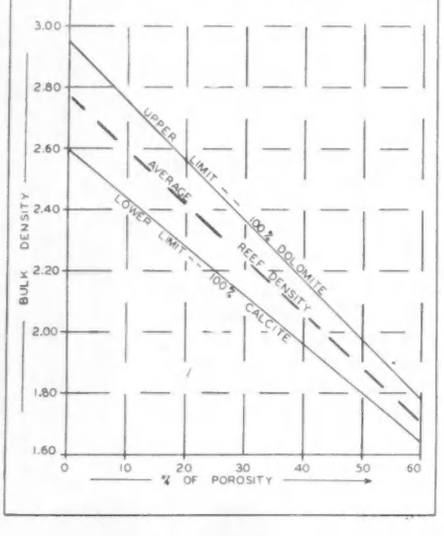


FIGURE 1

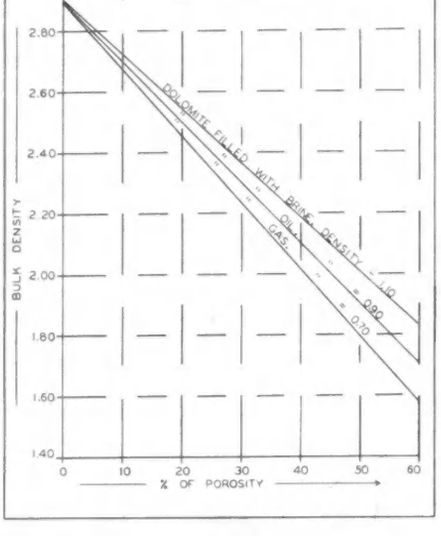


FIGURE 2

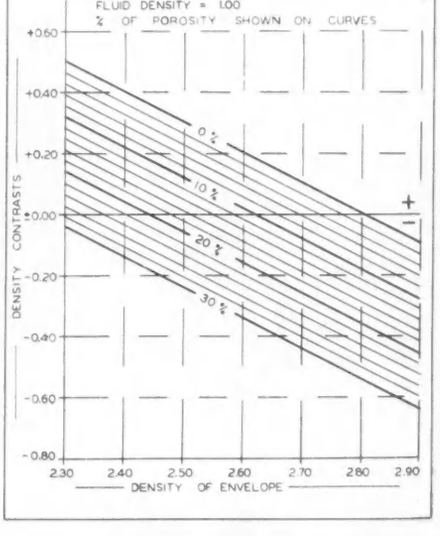


FIGURE 3

which faulting supplies the vertical components in what would otherwise be horizontally layered porosity differences.

In studying the first requirement, it must be realized that porosity is the main factor in producing the density ranges of sedimentary rocks, and in producing the density contrasts within each type of rock. Some recent density figures of basin filling rocks are given in Table 1.

TABLE 1

	Agnich[1]	Smith[2]	Theoretical
1st Group:			
Clay-Shale.....	1.40-2.60	1.20-2.70	1.20-2.80
2nd Group:			
Sandstone.....	2.0-2.5	2.00-2.60	1.91-2.70
Limestone.....	2.5-2.7	2.00-2.75	1.52-2.80
Dolomite.....	.....	2.10-2.90	1.60-2.95

The theoretical values have been computed from accepted mineral densities, possible porosities, and from the densities of the contained fluids. The first group contains the compactible clay-shale rocks, the density and porosity of which is a function of the maximum depth of burial attained in geologic history. The second group contains practically non-compactible rocks, which may have high porosities at great depths. Note the great overlap of the ranges of individual types of rocks as well as of the figures in the last two columns. The Agnich column should be disregarded for limestones and dolomites as he restricts himself severely, not including any dolomite reefs, and omitting limestone reefs of a density of less than 2.5. This figure could correspond to a porosity of approximately 10 percent, which may be the maximum porosity occurring in the reefs considered by Agnich. However, in other limestone reefs much higher porosities, and consequently, much lower densities, have been encountered.

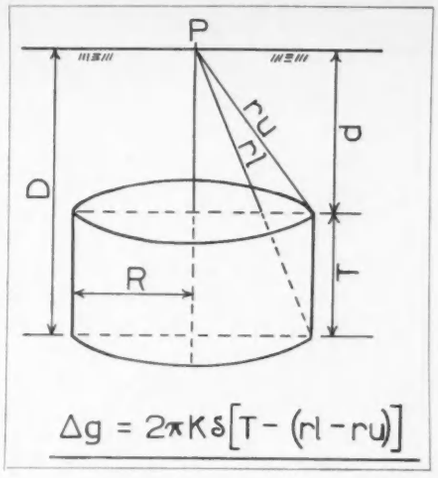


FIGURE 4

The large overlap of the density ranges of the sediments demonstrates that porosity is the prime factor governing the density. For all practical purposes, the average grain densities of the mineral aggregates composing the rocks listed above range between 2.50 and 2.95 grams per cubic centimeter, and the densities of the fluids filling the pore space range from 0.7 to 1.2 gm/cm.[3] The connecting link between these two quantities which go to make up the bulk density of a rock is the porosity, it being well known that under subsurface conditions all pore space is completely occupied by fluids.

Figure 1 shows the bulk densities of limestones and dolomites, in other words, of reef materials, as linear functions of the porosity. This figure also applies, of course, to other than reef porosities developed in limestones or dolomites, such as porosity developed by leaching, recrystallization, etc. At the left side of the figure, at porosity zero, the bulk density of the rocks corresponds to the average density of the mineral aggregates. In this case, it ranges from 2.60 gm/cm,[3] which is the lowest density of pure calcite, to 2.95 gm/cm,[3] which is the highest mineral density of pure dolomite. The figure shows the curves to a porosity of 60 percent, which may be the maximum attainable in modern reefs at or near the surface. For subsurface reefs, porosity figures higher than 30 percent are improbable, due to crushing and cementation of buried reefs. It is evident that the slope of the curves depends upon the initial points or grain densities, and upon the imaginary ultimate point at the right side of the figure, or a porosity of 100 percent, which would be the density of the contained fluid (in this case 1.0). The convergence of the curves within practical limits of from 0 to 30 percent of porosity is relatively small, which is to say that the density contrast produced by a given increase in porosity depends primarily upon that change in porosity, and only secondarily upon the mineral densities and fluid densities involved. Therefore, Figure 1 demonstrates in a practical manner that requirement No. 1 postulated above applies to porosity maxima in limestones and dolomites. Since the densities of sands making up sand lenses, and those of ordinary shale mineral aggregates, are very nearly the same and are near the lower limit of the reef range, that is, between 2.60 and 2.80, it is obvious that the

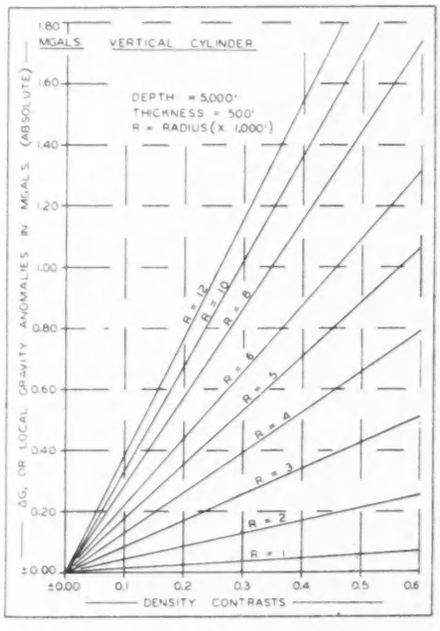

MGALS. VERTICAL CYLINDER
DEPTH = 5,000'
THICKNESS = 500'
R = RADIUS (X 1,000')
ΔG, OR LOCAL GRAVITY ANOMALIES IN MGALS. (ABSOLUTE)
DENSITY CONTRASTS

FIGURE 5

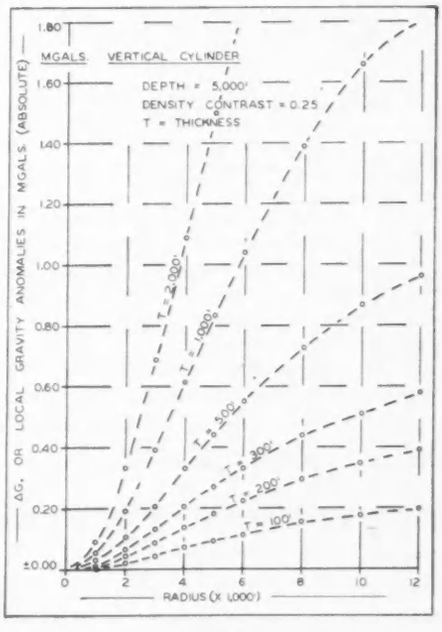

MGALS. VERTICAL CYLINDER
DEPTH = 5,000'
DENSITY CONTRAST = 0.25
T = THICKNESS
ΔG, OR LOCAL GRAVITY ANOMALIES IN MGALS. (ABSOLUTE)
RADIUS (X 1,000')

FIGURE 6

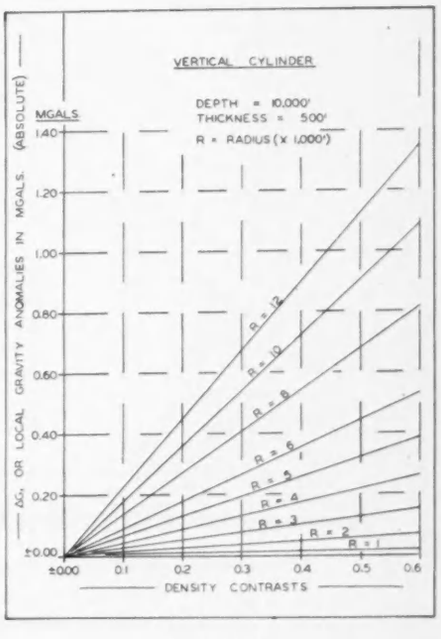


FIGURE 7

reasoning of Figure 1 applies equally to sand lenses in shales, and to shoe string sands.

Figure 2 shows the effect of the fluid content on the bulk density of porous masses. The example given is a dolomite of a mineral density of 2.90 filled with brine of a density of 1.10, with oil of a density of 0.90, and with gas of a density of 0.70. It is obvious that the type of fluid occupying the pore space has an appreciable effect upon the bulk density. In any problem where a definite gas cap exists, underlain in turn by an oil zone and a water zone, it will be necessary to consider the densities of the contained fluids for exact calculations of the gravity effects produced by the various zones, as soon as the porosity exceeds nominal values.

Concerning the second requirement, that the resulting density boundaries or interfaces must have attitudes involving relatively large vertical components, we may refer to the literature for known thicknesses and profiles of reef buildups. Often profiles are given which show the rapid change of the lithofacies, or the rapid gradation from envelope to reef rock through a short lateral zone. P. B. King[3] shows the San Andres reef with a maximum thickness of 2400 feet in his monograph on the "Permian of West Texas and New Mexico." W. T. Schneider[4] shows the porous part of the San Andres to be 1000 feet thick in the Wasson Oil field of Gaines and Yoakum counties, Texas. Neal Clayton[5] shows a reef buildup of 1100 feet in the Standard-Brown 5-2 well in the North Snyder Area of Scurry County, Texas.

The fact that a large vertical component is involved is also demonstrated by the rapidity of the dip of the reef surface. For instance, three recent wells in the Wellman field of Terry County showed the surface of the reef to dip about 500 feet within two locations (Magnolia Scales 1 to Anderson-Prichard Bevers 2). It may be stated, therefore, that the second requirement listed above is certainly fulfilled in the case of many of the porosity maxima under consideration here.

The third requirement, that the total anomalous mass must be large enough so that the gravity effect exceeds decisively the probable error of the method used, could also be shown to be fulfilled in the case of many subsurface reefs by means of the observed gravity pictures and the known dimensions of the porosity maxima as developed from drilling. However, since many of these features are still in the development stage, the field data are still held in strict confidence in the majority of cases. Instead, it will be shown below by means of a few simple calculations that many porosity maxima will fulfill the third requirement.

Figure 3 is a density contrast chart applying to many reefs. It has been computed for an average mineral density of 2.80 gm/cm,[3] and for porosities varying from 0 to 30 percent, in steps of 2 percent. In this chart, the density contrast has been plotted as a function of the envelope density, and the latter has been made to vary from 2.30 (a light shale) to 2.90 (a tight dolomite). It will be seen that this chart clearly defines all cases in which the density contrast is zero as well as those in which the contrast is positive or negative. The chart may be used to estimate the expected density contrast from known or assumed geological conditions, or to estimate the expected porosity when the density contrast can be estimated from a gravity anomaly combined with other subsurface information. Similar charts may be constructed for any desired mineral density, fluid density, percentage range of the porosity, and density range of the envelope.

Figures 4 to 9 show the gravity

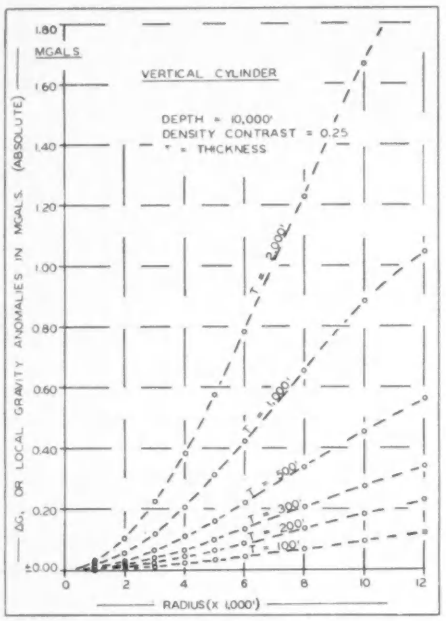


FIGURE 8

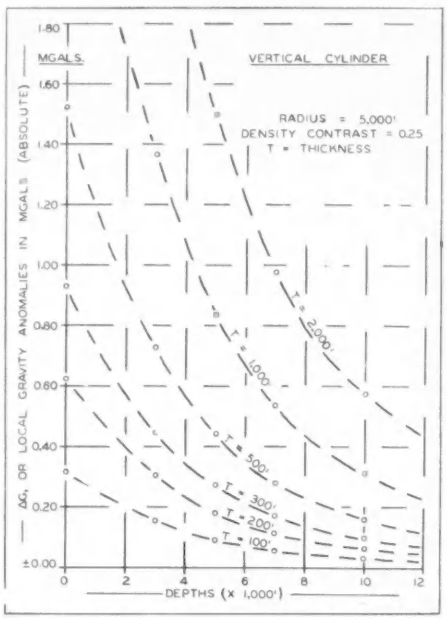


FIGURE 9

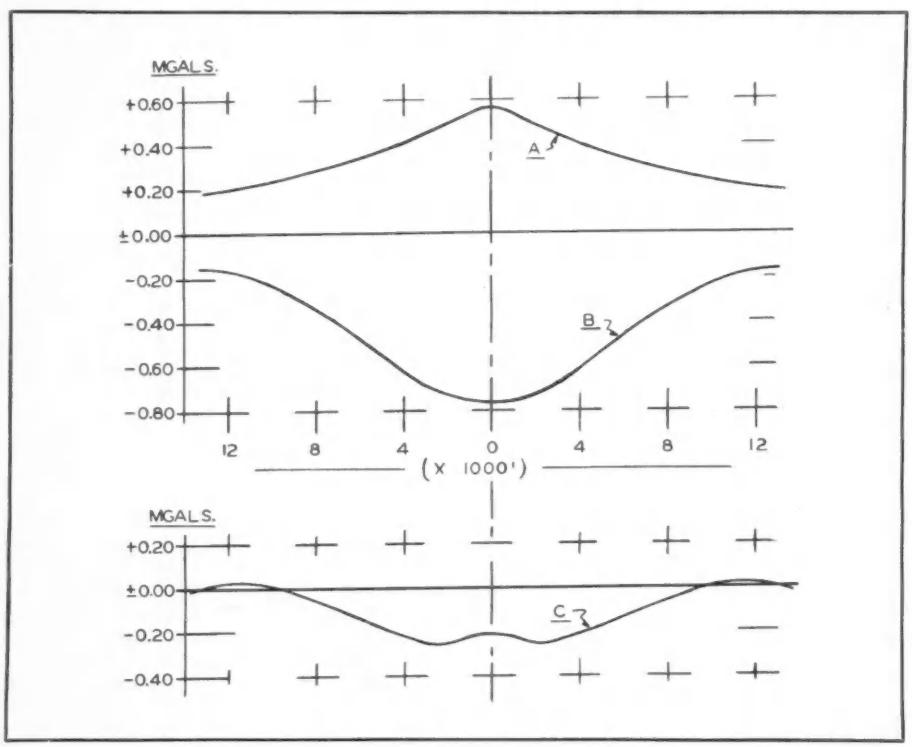
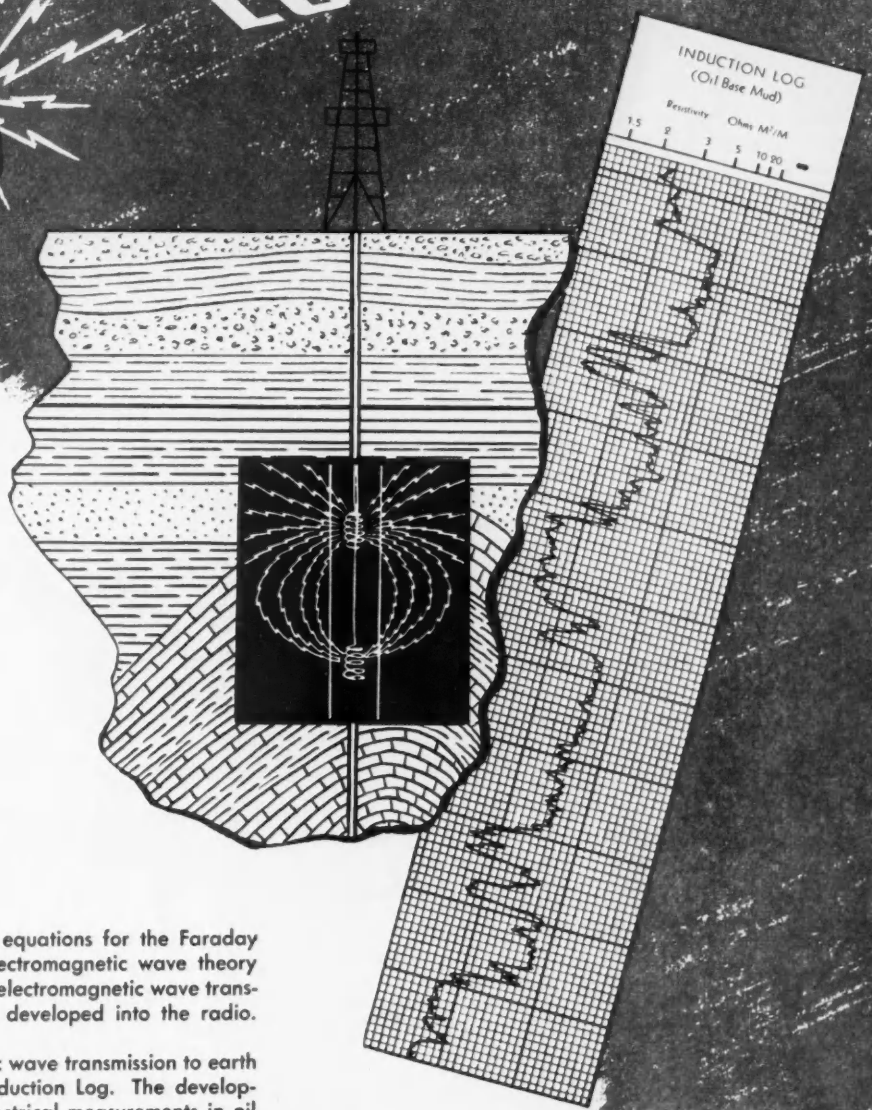


FIGURE 10

THE SCHLUMBERGER INDUCTION LOG



...in OIL BASE MUDS or in CABLE TOOL HOLES where no mud column exists

In 1831 Faraday made one of the most important electrical experiments in history when he discovered the operation of the induction coil. The ignition systems of our modern automobiles remake this Faraday experiment for us countless times each day.

In 1855 Maxwell developed the mathematical equations for the Faraday induction coil experiments and, as a result, the electromagnetic wave theory was born. In less than 100 years man has harnessed electromagnetic wave transmission in many ways. The wireless telegraph was developed into the radio. After radio came radar and television.

In 1946 Schlumberger adapted electromagnetic wave transmission to earth measurements for the first time by means of the Induction Log. The development was undertaken in order to obtain precise electrical measurements in oil base muds, or in cable tool holes which have no mud column. Conventional resistivity curves are difficult and sometimes impossible to obtain under such conditions because electrical contact with the formation is uncertain.

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effects of a vertical cylinder which is a crude approximation to the shape of many porosity maxima. Others may be approximated by infinite horizontal prisms. These figures were selected from a large group of charts computed for the purpose of estimating the gravity anomalies resulting from certain assumed dimensions of porosity maxima, and to approximate the density contrasts of porosity maxima when the gravity anomaly was given, and the depth and probable thickness were known from seismograph work and limited drilling. The charts demonstrate conclusively that anomalies exceeding the probable error of the gravimetric method may be confidently expected in the case of many porosity maxima.

Equally important is the fact that the charts demonstrate that for a given depth and density contrast there must be a minimum thickness and a minimum radius or width of the feature before a noticeable gravity anomaly is produced. This is the valuable factor pointed out above which makes it possible to use gravity work as a safeguard to insure the presence of a properly sized target before a well is drilled. For instance, in the case of the one-well Petersburg field[7] of Hale County, Texas, which is surrounded by four dry holes, the gravity anomaly due to reefing expected from these charts would be approximately 0.03 milligal, or much less than the probable error of a gravitymeter survey. Therefore, it could have been predicted from a gravity survey of this locality that if reefing were present, it would have to be insignificant. With reef wells being drilled to the neighborhood of 10,000 feet, the ability of gravity work to distinguish between worthwhile targets and uneconomical ones is undoubtedly a very valuable contribution.

From the foregoing it would appear that most of the larger and more important porosity maxima do yield measurable gravity effects. In many cases, these effects would be closely associated with structural effects. Particularly in the case of reefs, we will map interference patterns in the majority of cases rather than purely the effects of porosity maxima. These interference patterns will consist of a number of positive and negative contributions, varying from case to case. R. A. Pohly[6] gave the first clear statement of this situation at the Chicago meeting of the Society of Exploration Geophysicists in April, 1950. He termed the significant reef anomaly a "double anomaly." We have been calling them "ring anomalies" in our work, and this term has also been used by Neal Clayton in his recent paper on the North Snyder area.

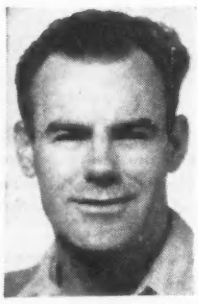
Figure 10 will give a crude sketch of our own idea on the subject, for a good San Andres reef anomaly. Curve A is the sum of all positive contributions, the sharpening at the center being attributed to thinning of the salt, compaction of the red beds, and to shallow anhydrite structure. Curve B shows the effect of reefing at a depth of 5000 feet, with a thickness of 500 feet, and a width of an infinite rectangular block of 10,000 feet. In the thickness of 500 feet, is included, of course, the entire porosity maximum, and not merely the pay zone. The pay, or oil- and gas-bearing top of the porosity maximum was taken as 150 feet in thickness in this case, underlain by 350 feet of water-bearing porosity. The density contrast of the porous mass to the tight dolomite on either side was taken as —0.25 gm/cm.^{3} Curve C represents the composite anomaly, or the sum of Curves A and B. In other cases, the central maximum could grow at the expense of the general minimum, or the two slight flanking maxima could grow and the central maximum could disappear, leading to many different possible configurations. In any event, our experience in the Permian Basin fully confirms Pohly's conception of a "double anomaly."

A few notes on cooperation between seismograph and gravitymeter in the search for porosity maxima may be in order. It has been pointed out above that the gradation from non-porous to porous rocks must be relatively fast, as one of the requirements for obtaining measurable gravity effects. Depending upon the size and depth, this gradation could occur within a few feet, or a few hundreds of feet, to be still very effective in gravity work. However, the seismic reflection method requires a clear-cut boundary as an interface between rocks of different velocities in order to produce useable reflections. While this may be the case in some reefs (see Neal Clayton,[5] op. cit., p. 1) there will be many reefs or other porosity maxima where the gradation is not rapid enough to produce seismic reflections. In these cases, the reflection seismograph has to work indirectly, as was ably shown by Agnich,[1] through the structure of overlying beds, abnormal rates of thinning, etc. Furthermore, the large vertical component involved in the attitude of the boundary of many reefs favors gravity work, but is often unfavorable to seismic reflection work.

By its very nature, the seismic reflection method works excellently on horizontal or moderately dipping reflecting surfaces, but as dips become steeper the method becomes less effective; on the other hand, the greater the dip the more effective are the gravity methods. An additional consideration is that the seismograph might be restricted to a definite surface or marker whereas the gravity methods work by virtue of the entire anomalous mass involved. For instance, in the case of the Wasson field, Gaines and Yoakum counties, Texas, the thickness of the porosity maximum is 1000 feet according to

About the Authors

H. KLAUS, a native of Germany, received his education at the University of Goettingen, and at the Institute of Technology, Berlin-Charlottenburg. He worked for various subsidiaries of Gulf Oil Corporation as torsion balance party chief and seismic interpreter from 1927 to 1936. He then organized Klaus Exploration Company, specializing in torsion balance, gravimeter, and magnetometer work.



JOHN C. HUGHES was born at Celeste, Texas, in 1917. He began his engineering education at Texas Technological College in late 30's, interrupting it in 1939 for practical geophysical experience with Klaus Exploration Company, where he now supervises all office computations and drafting. He is also continuing work at Texas Tech in Lubbock, majoring in geology.

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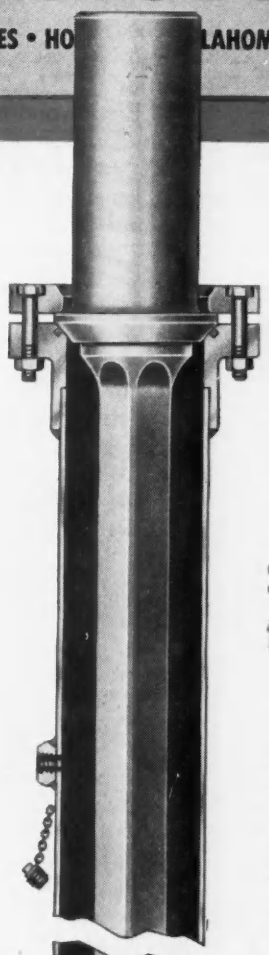

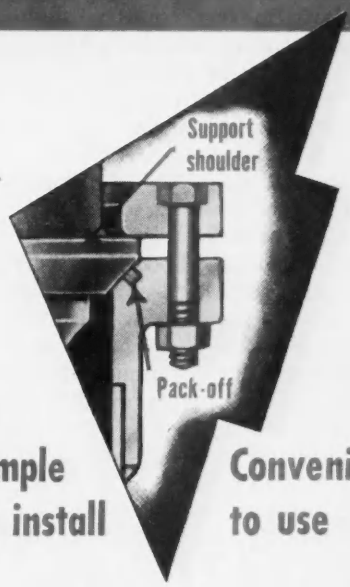

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Illustrated is the Baash-Ross Kelly Scabbard providing sufficient clearance for kellys having rubber protectors. Note centralizing support that maintains accurate kelly alignment. A closer-fitting type is also available for kellys where no rubber protectors are used.

W. T. Schneider,[4] but the structural closure amounts to only 140 feet. For these reasons, a detailed gravity picture should be obtained in all cases where the possible presence of a porosity maximum is suspected. Particularly in reef country, slight terracing, nosing, unusual dips, and abnormal rates of thinning detected by the seismograph or subsurface work should be investigated by detailed gravity surveys.

The advantage of gravimetric methods of reacting to the entire anomalous mass is shared by the refraction seismic method. Therefore, the foregoing considerations would tend to stress the importance of this method, although Agnich's appraisal of it is not very optimistic. He anticipates time leads from this method ranging only from 11 to 22 milliseconds, from reefs ranging between 500 and 700 feet in thickness, and with velocity contrasts of from 4000 to 5000 feet per second. While such a time lead in itself would not be very strong evidence, the simultaneous mapping of a "double anomaly" with the gravitymeter in the same locality would be very important evidence indeed, and would undoubtedly justify an intensive exploration effort.

In conclusion, it should be kept in mind that other porosity maxima than reefs may be of great importance in the future, as they have been in the past. While the attention of the industry has been focused upon reefs through the spectacular developments in Scurry County, Texas, and Alberta, Canada, future years may show that other types of porosity maxima may again be of great importance. Exceptional possibilities may be present in sand bodies enclosed in large shale deposits in deep basins, and in leached limestones and dolomites occurring at unconformities throughout the oil country. Gravity work is destined to play an increasingly important role in exploring these hitherto neglected porosity maxima.

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North Dakota

■ CONTINUED FROM PAGE 75

hook beds, the Madison group, the Big Snowy group, and the Amsden formation.

The Englewood or Kinderhook formation consists of about 25 to 110 feet of rather dark carbonaceous shale, green-gray shale, some limestone, and gray siltstone or sandstone. This is apparently approximately equivalent with the black shale found at similar intervals practically everywhere in the U. S. It makes a fine marker bed and is present in the subsurface in most wells.

Overlying the Englewood is the Madison group, which can be divided into two formations, the Lodgepole below and the Mission Canyon above. In general the Lodgepole formation consists of 75 to 880 feet of gray to buff granular to dense limestone with considerable chert in some localities, especially in Montana. This is the thicker of the two formations in the Madison group. Overlying the Lodgepole is the Mission Canyon formation (80-530 feet thick) which consists of oolitic to fragmental, buff to light tan limestones which are sometimes cavernous at the surface. It is in the upper part of this formation where vugular porosity is frequently developed in which oil stain has been noted. Some free oil has been noted at this horizon in the J. H. Downey 1 of the Souris Valley Petroleum Company mentioned previously.

Overlying the Madison is the Big Snowy group, consisting of four formations, started from the base upward—the Charles, Kibbey, Otter, and Heath. The Charles is of considerable interest because it consists of a section of dolomitic limestones and considerable anhydrites and some variegated colored shales from 50 to 890 feet thick. There is considerable question as to whether or not the Charles should be separated from the underlying Madison, inasmuch as its lithology with the exception of the abundant anhydrites is similar. In fact, there is one large anhydrite, approximately 100 feet or so below the top of what is frequently called Madison. Some would include this anhydrite in the Charles; others include it in the Madison. There appears to be no clear-cut contact between the two formations. It has been suggested that the Charles may be the subsurface equivalent of the upper part of the Madison which does not show readily at the surface. Perhaps it has not been recognized due to the absence of the anhydrite at the surface. In any event, it was included originally in its definition by Seager in the basal part of the Big Snowy group.[3]

The Charles is overlain by the Kibbey formation, consisting of 60 to 300 feet of variegated shales with red and gray sandstones near the base. The sandstones are rather poorly sorted, and therefore there is some question as to whether they would make a good oil-bearing horizon. However, oil has been found in the Kibbey in eastern Montana.

Overlying the Kibbey is the Otter, which in the outcrop is a bright green shale. In North Dakota, however, it is difficult if not impossible to separate the Otter from the overlying Heath. The Otter varies from 0 to 100 feet in thickness. Some anhydrite is noted in the Otter, and a limestone bed is sometimes present at the top.

Overlying the Otter is the Heath, which varies from 0 to 335 feet in thickness and consists of black carbonaceous shale, some gray to green shale, and dolomite, with some small lenticular sandstones occasionally present. These sandstones, which have produced oil in eastern Montana, appear to be in the nature of offshore bars.

Overlying the Heath is a controversial formation known as the Amsden. The Amsden varies from 0 to 250 feet in thickness in North Dakota, and consists of orange, red, purple dolomitic limestone, dolomite, and shale. The Amsden in North Dakota is herein being placed in the Mississippian, but there are several geologists who would place it in the Pennsylvanian. In any event, the lower part of the Amsden apparently is what is present in North Dakota, and if it is correlative with the lower part of the Amsden in Montana, it probably should be placed in the Mississippian. This, however, is an open question which must be solved when more data are available.

PENNSYLVANIAN: The writer does not believe the Pennsylvanian is present in North Dakota except perhaps in the southwestern corner of the state. There it is represented by the Minnelusa formation which varies from 0 to 200 feet in thickness. This formation consists rather largely of white anhydrite, sandstones and limestones and is not extensively developed.

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VELOCITY Information

Needed for Seismic Interpretation

By JOHN W. DALY

General Geophysical Company, Midland, Texas

THIS article is written with only one goal, and that is the recognition within the industry of the need for better velocity information. It is important that the oil finding rate of the seismograph be maintained and improved. In most budgets which encompass an integrated exploration plan the amount allocated to seismograph work usually is one of the major items. Not only is this amount in itself a major item, but in addition much of the subsequent expenditure for land and drilling is contingent on the information produced by the seismograph.

The necessity for obtaining the maximum return from the sum spent for seismograph work cannot be overemphasized. While most geophysicists recognize the need for better velocity control, it frequently happens that the decision to shoot wells or otherwise obtain velocity data is the prerogative of men not aware of the problems that must be solved. It is the writer's experience that whenever these executives are made cognizant of the role that velocity data play in seismograph interpretation, complete cooperation is usually forthcoming.

In the following paragraphs, illustrations of the relationship between changing lithologies and changing velocity patterns are given. These are based on conditions which obtain in West Texas and New Mexico and are factual. This area was chosen because here the velocity changes are most severe and consequently most striking and it is the area with which the writer is most familiar. Other basins, too, have their velocity problems which, while not as severe, have a critical effect on the resolving power in those regions of the seismograph as an oil finding tool.

In the upper portion of Figure 1 an idealized generalization of the recognized facies of typical Permian sedimentation is illustrated. The principal rock types are represented by symbols, and the characteristic inherent velocities are shown for each lithology.

MORE EXTENSIVE velocity information is essential in connection with seismograph work. Better velocity control is needed to assure correct interpretations and to obtain maximum return from sums spent for seismograph work. Although velocity surveys are expensive, their cost is minor in relation to the total cost of a seismograph program.

While it is recognized that generalizations such as this are subject to criticism, at the same time this is a sedimentation sequence that has long been recognized by the geologists who have worked in the Permian Basin.

The central portions of the basins which were presumably the deepest parts and the parts farthest from shore, received principally deposits of fine-grained clastics. These black, green and gray shales and fine silty sands, of which the Sprayberry and Dean sands are examples, have a velocity of approximately 12-13,000 feet per second. As we proceed shoreward, these clastics grade into and interfinger with dark, hard, tight, bedded limestones and eventually are completely replaced by these offshore precipitates. This basin-type limestone has a range in velocity from 16-18,000 feet per second. As the shoreline is approached, the precipitates change in character. They become clean, massive, dolomitic and porous. Velocities measured in sections of this type of deposit show variations of from 18-24,000 feet per second. As nearly as this can be correlated, the cleaner and more dolomitic portions have the highest velocity. Some workers think that the value 24,000 feet per second is too high, but it is the writers' belief that some measurements of this magnitude are credible. Certainly, interval values of from 22-23,000 feet per second are common.

Back of the shore line reef, or landward, the massive material grades laterally into hard, tight, gray, bedded limestone and dolomite. Although this material might differ genetically and in appearance from that limestone deposited offshore, its response to sound waves is similar. They travel through these rocks at 16-18,000 feet per second. The limestones and dolomites of this location gradually become interfingered with the common evaporites, halite and anhydrite, until finally massive sections of these materials are found. A nearly constant velocity of approximately 14,000 feet per second is common to these salts. Proceeding shoreward, these evaporites give way to the gypsiferous, variegated, sands and clay shales characteristic of nonmarine deposition. This material has a wide range of response to sound waves and they travel through it at rates which vary from 8-12,000 feet per second.

In the lower portion of Figure 1 is shown by graph the two-way travel time through 3000 feet of the above sediments. This has been computed assuming linear changes in the velocity between the extreme values designated for each rock type. This graph represents the profile of an isochron map that would be obtained if one were to shoot on the top surface of the section shown in the upper part of this figure and map a reflection from a constant depth of 3000 feet. The two-way time through the basin type section is one-half second. It gradually decreases toward the shoreline as more and more of the high velocity material is included within the constant interval of 3000 feet. At the shoreline where the highest velocity material occurs the two-way travel time has decreased to one-fourth second, a 100 percent change. After reaching this minimum the time gradually increases shoreward until in the lowest velocity clastics a two-way travel time of three-fourths second is observed, a 300 percent change from the minimum. If this range of travel times

had been observed in a reflection survey, and the data computed at a constant velocity of 14,000 feet per second, there would have been shown a dip of 1750 feet toward the left side of the figure and 3500 feet toward the right side of the figure. This would be an error by an amount in excess of the total thickness of the unit being surveyed. This would be a false structure of magnificent proportions. False structures due entirely to circumstances as described above have been shot and have been drilled.

In the Pennsylvanian section in this area we are, apparently, dealing only with the basin type sediments. At least we do not observe the dolomites, shoreline or back-reef facies. The upper part of Figure 2 represents a cross section of an alleged Pennsylvanian reef. These bioherm deposits are surrounded by typical basin type clastics, dark colored shales and sands, with velocities characteristic of these sediments, 12-14,000 feet per second. The reef materials have velocities of 16-18,000 feet per second, which are comparable to those observed in typical basin type limestones. In the lower portion of the figure a graph shows the two-way travel time through 2000 feet of Pennsylvanian clastics in a portion of which 1200 feet of reef have been buried. The two-way travel time remains constant at about one-third second until the reef material is encountered and then it decreases to about one-fourth second at the thickest part of the reef, a decrease of about 20 percent. If we were shooting at the top of the Pennsylvanian and recording a reflection from a constant depth of 2000 feet, we would observe a decrease in travel time over the reef of 0.067 second. If these travel times were converted to depth, using a constant velocity of 12,000 feet per second, we would map a reversal amounting to 402 feet over the reef. In this particular case, the velocity change operates to the advantage of the geophysicist, since it is immaterial whether or not the feature mapped is a structure or a velocity anomaly due to reefing. The important thing is to find oil. To date, velocity anomalies mapped in the Pennsylvanian rocks have paid rich rewards, but to the writer's knowledge this is not true of the Permian section. Perhaps some day these, too, will pay off.

The geophysicist uses his velocity data in the following ways:

- For orientation purposes.

The seismograph measures only the time it takes for a sound wave to travel from a shot, to a reflector and back to the surface. This sound wave is recognized by the seismologist and its arrival time recorded. The only way in which he can determine the depth of the reflector, is to know the velocity of the medium in which the sound waves travel. Only by shooting close to a well in which a velocity survey has been made can the reflections be identified with lithologic or time stratigraphic changes.

- For correlation purposes.

Seismograph traverses that are computed using a constant vertical velocity distribution sometimes do not check the relief determined by geologic correlations. This is generally attributed to some inherent fault or weakness in the seismograph work and method. This might be true in areas of poor seismograph records, but where records are good and when the field work and interpretation are properly handled, any discrepancy between seismic data and geologic data must be at-

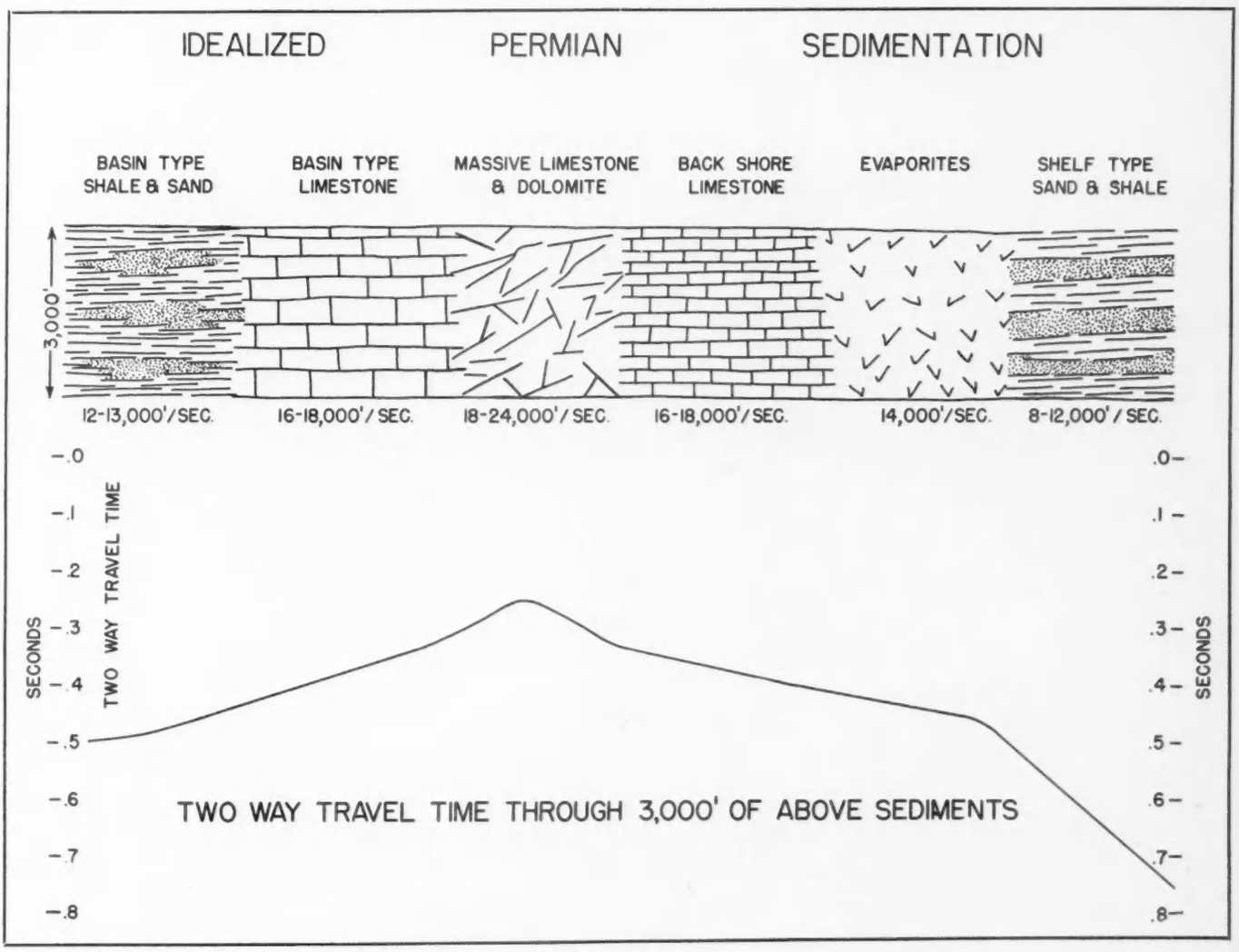

FIGURE 1

tributed either to velocity changes or to erroneous geologic interpretation.

To repeat, the seismograph does not measure depth, it measures time. That is all it is designed to do. The translation of these measurements into depth must be done according to the equation depth equals time, multiplied by velocity. In correlating between wells, it is essential to have velocity surveys in each of them; otherwise, it is impossible to determine if mistying is due to velocity, faulty seismograph work or erroneous geology. If velocity surveys are unavailable, a qualitative approach to the problem is possible by considering the lithologic sections in the wells. The well having the greatest percentage of high speed material, clean dolomites and limestones, in contrast to evaporites or clastics, will have the higher velocity.

- For correction purposes.

Once a velocity gradient is established by three or more wells, it is possible and frequently desirable to correct the seismograph maps for this changing velocity. This can be accomplished by any one of several possible methods. The procedure usually involves certain simple assumptions regarding the velocity distribution between control points. Such a corrected seismograph map yields a much closer approximation to the true structural configuration than does an uncorrected map.

- For purposes of interpretive predictions.

The Isochron

An isochron is a line representing equal time. If seismograph maps are carried in time, since that is what is measured, instead of depth, which is a product of time and velocity, then the contours on a time map are isochrons. If the time interval between successive horizons is contoured, such contours can probably be called isochronopachs and are lines denoting equal time intervals. Studies of this type have been made for years by the more adept geophysicists and in conjunction with known facts related to regional velocity distribution permit interesting predictions in regard to the behavior of the geologic section. As demonstrated in Figures 1 and 2, changes in the time interval are related to lithologic variation in a particular time stratigraphic unit. By the aforementioned equation time is equal to depth or distance divided by velocity. Thus time maps, or time interval maps, represent two variables: distance and velocity. If by regional well control we can know what is happening to the various stratigraphic intervals, then we can estimate to what degree time changes are related to changing geologic interval and how much to varying velocity. The velocity changes can then be related to lithology. Conversely, if we have good velocity control, we can readily estimate the amount by which the variations in the time interval are related to changes in thickness. If changes in time are related to changes in distance or thickness, we deal with structure; otherwise, time changes are related to lithology. Before undertaking studies of this type it is desirable to have good regional velocity control, as well as all possible well control.

While well velocity surveys are expensive, the cost of velocity information is minor in relation to the total cost of a seismograph program. Since there are a finite number of wells that have been surveyed for velocity and since the possible number of crew months of shooting is almost infinite, it is immediately evident that as a seismograph program matures, the percentage spent for velocity surveys becomes less and less. The cost of velocity information for one independent operator who has almost all of the available surveys in the West Texas-New Mexico area is now approaching 1 percent of his total expenditure for seismograph work. In the major companies this expense would represent a far lower percentage of their total shooting cost. The benefits which accrue from having adequate velocity control are strikingly disproportionate to the percentage cost of this information.

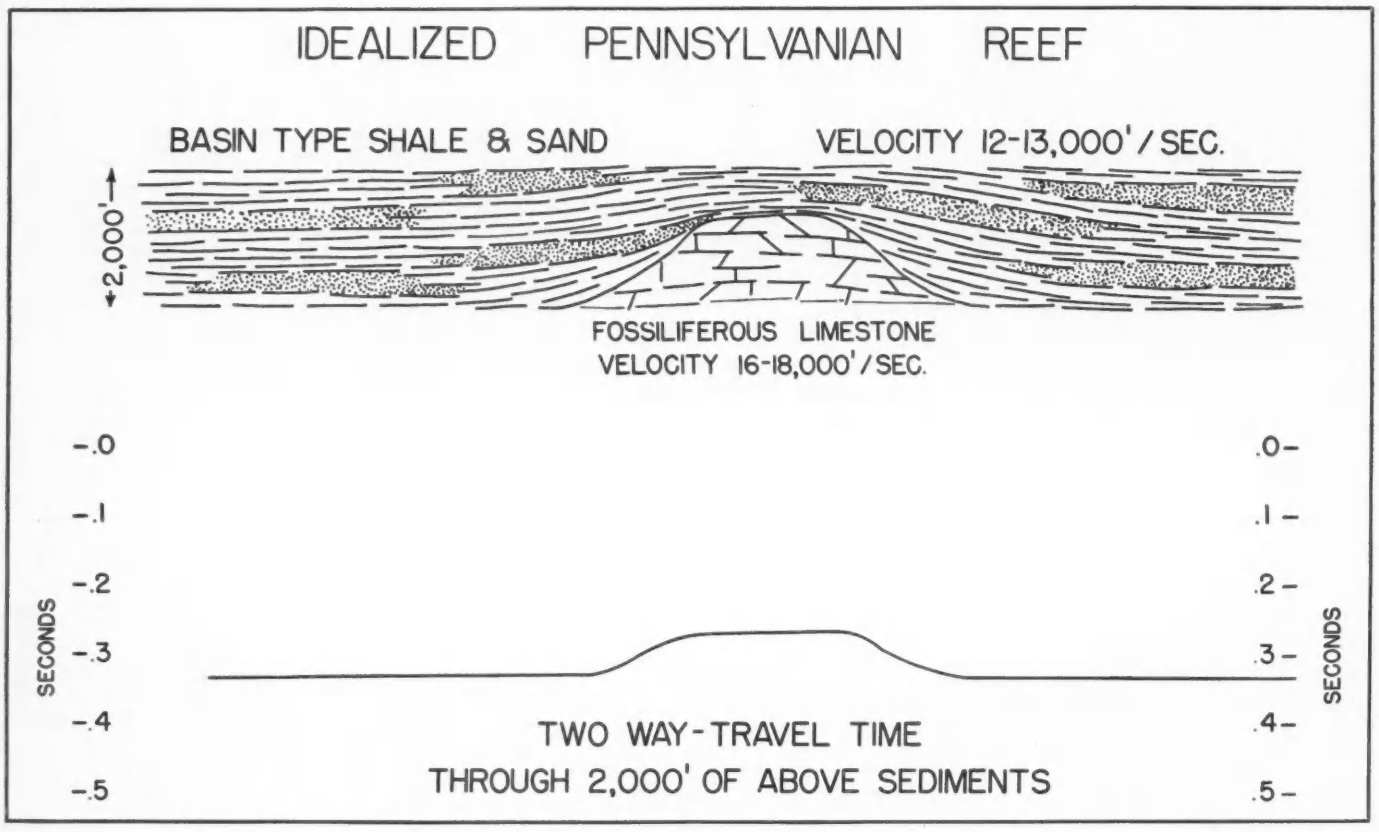

FIGURE 2

THESE CLEAN CUTTINGS MEAN MORE PRODUCTION—CLEANER HOLES

A seismograph crew drilling shot holes in South Texas drilled a clean, straight 80-foot hole through hard shale, clay and gravel in 20 minutes. Notice in the photograph above, the extra-clean cuttings of uniform size made by the Hawthorne "Blue Demon" Rock Cutter Bit.

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Exploration

20 Percent Above 1950 Level

A HIGH for the year of 809 exploratory tests was completed during April to boost the year's four-month total into a lead of almost 20 percent over last year's record. April's wells totaled 60 more than those completed during the previous month and 195 more than were credited to April of last year.

Besides the total number of exploratory well completions being at above-the-average level, the percentage that proved to be producers also was above the normal. April's tests yielded 163 producing wells for a score of 20.1 percent of the total drilled, while the average for the first four months of this year amounted to only 19.5 percent and even that was slightly better than the previous year's record of 19.4 percent.

A total of 114 new oil pools were discovered during April to top last month's 108 new oil sources and to bring the year's total up to 391. At the same time a year ago the count had been 304 new oil pools discovered; and the comparison gives the current oil finding program a numerical lead of 28.6 percent. The month's 114 new oil pools were composed of 83 new fields and 31 new pay horizons in established fields.

New distillate discoveries made during the month numbered six, compared with the previous month's five.

Summary of Results of Exploratory Drilling

	April, 1951	Mar., 1951	FOUR MONTHS: January-April 1951	1950	Percent Diff.
Oil Discoveries	114	108	391	304	+ 28.6
New Fields	83	70	271	222	+ 22.1
New Pays	31	38	120	82	+ 46.3
Distillate Discoveries	6	5	23	27	— 14.8
New Fields	5	3	17	23	— 26.1
New Pays	1	2	6	4	+ 50.0
Gas Discoveries	12	17	57	42	+ 35.7
New Fields	7	13	41	37	+ 10.8
New Pays	5	4	16	5	+220.0
Total Discoveries	132	130	471	373	+ 26.3
Extensions to Fields	31	22	93	95	— 2.1
Oil Fields	23	15	67	84	— 20.2
Distillate Fields	2	1	9	3	+200.0
Gas Fields	6	6	17	8	+112.5
Total. Prod. Tests	163	152	564	468	+ 20.5
Dry Holes	646	597	2,325	1,945	+ 19.5
Wildcats	607	553	2,177	1,858	+ 17.2
New Pays			4	5	— 20.0
Outposts	39	44	144	82	+ 75.6
Total Expl'tory Tests	809	749	2,889	2,413	+ 19.7
Percent Productive	20.1	20.3	19.5	19.4	
Percent Dry	79.9	79.7	80.5	80.6	

Results of Exploratory Drilling in April and First 4 Months, 1951-1950 by Districts

State or District	MONTH OF APRIL, 1951													FIRST FOUR MONTHS, 1951																	
	Productive Tests										Unproductive Tests				Productive Tests									Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive				Total Exploratory Tests	New Fields			New Pays			Extensions			Total Productive		Wildcats	New Pays	Outposts	4 Mo. 1951	4 Mo. 1950	4 Mo. 1951	4 Mo. 1950
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	4 Mo. 1951	4 Mo. 1950							
Alabama											3			3				1			1			2	1	6			6	6	8	7
Arizona																										2			2		2	
Arkansas	2			3			1			6	10		1	17	3			4			1			8	4	20		4	24	24	32	28
California	2			1			2			5	31		6	42	5		1	4			4			14	15	152	2	18	172	115	186	130
Colorado	1					1				2	9			11	1					1				2		27		1	28	11	30	11
Florida											1			1												1			1	4	1	4
Georgia																														3		3
Idaho																										1			1	3	1	3
Illinois	2			4						6	40			46	5			7			6			18	29	125			125	189	143	218
Indiana	4									4	15			19	9			3						12	11	90			90	116	102	127
Kansas	10			2						12	62			74	46		2	11						59	31	216			216	148	275	179
Kentucky	1						1			2	10			12	2			2			3			7	3	34			34	13	41	16
Louisiana	1			1		1	2			5	21		2	28	10		1	10	1	2	6			30	31	18		9	90	63	120	94
North Louisiana	1					1	1			3	14		1	18	4			2	1	2	3			12	8	46		2	48	26	60	34
South Louisiana				1			1			2	7		1	10	6		1	8			3			18	23	35		7	42	37	60	60
Maryland																														1		1
Michigan	1									1	27			28	4		2			1				7	14	84			84	85	91	99
Mississippi					1					1	6			7	1	2		2	1					6	11	30		3	33	51	39	62
Missouri																														2		2
Montana											3			3							1			1	1	5		2	7	18	8	19
Nebraska	1								1	2	6			8	3								3	6	3	15		2	17	11	23	14
Nevada																										1			1		1	
New Mexico	2		1							3	10		1	14	4		4	3			2		1	14	14	25		4	29	19	43	33
North Dakota																										1			1		1	
Ohio											3			3							1		3	4	2	10			10	5	14	7
Oklahoma	6			1		1	5	1		14	48			62	22		2	7		1	12	2	2	48	44	208			208	141	256	185
South Dakota																														2		2
Tennessee																														3		3
Texas	49	5	5	19		2	11	1	5	97	295		27	419	152	15	27	61	4	10	26	7	8	310	250	1011	2	95	1108	880	1418	1130
Dist. 1 S. Central	2		1						1	4	12		2	18	10		1	1					1	13	6	54		6	60	63	73	69
Dist. 2 Middle Gulf				7		1	1		1	10	13		3	26	4	4	6	11		5	2		1	33	18	53		17	70	40	103	58
Dist. 3 Upper Gulf	4	2	2	2		1			1	12	21			33	8	4	7	14	2	2	1	1	1	40	28	80		2	82	64	122	92
Dist. 4 L.Gulf-S.W.	4	1	1	4			1	1	1	13	24		3	40	11	4	2	13	1	2	2	1	2	38	34	87	1	15	103	93	141	127
Dist. 5 E. Central		1		1			1			3	8		1	12	1	1		2			3			7	2	59		1	60	21	67	23
Dist. 6 Northeast	1	1		1			1			4	5			9	3	1		1			1	5		11	8	23			23	33	34	41
Dist. 7-B N. Cent.	23		1				2			26	101		1	128	51		7	5			3		2	68	51	279		4	283	186	351	237
Dist. 7-C W. Cent.	5									5	23			28	19	1	1	2	1		4			28	14	88		2	90	76	118	90
Dist. 8 West	3			4			2			9	33		1	43	16		2	7			5			30	46	120	1	9	130	98	160	144
Dist. 9 North	7						3		1	11	51		16	78	28			5		1	5		1	40	42	162		39	201	202	241	244
Dist. 10 Panhandle											4			4	1		1							2	1	6			6	4	8	5
Utah											3			3	1									1	1	7			7	4	8	5
Washington																														2		2
West Virginia			1							1				1			2							2							2	
Wyoming	1						1			2	4		2	8	3			5		1	4			13	3	25		6	31	26	44	29
Total U.S.	83	5	7	31	1	5	23	2	6	163	607		39	809	271	17	14	120	6	16	67	9	17	564	468	2177	4	144	2325	1945	2889	2413

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U. S. Oil, Distillate and Gas Discoveries and Extensions in April

ARKANSAS—NEW OIL FIELDS

Miller County. Skelly Oil Company's Louis Heilbron 1, C NW NW NE 28-16s-26w, flowed 798 barrels from Basal Paluxy sand, Lower Cretaceous 4180-4188 feet, 44.6-gravity, ¼-inch, completed 4-12-51, TD 4281.

Nevada County, Willisville field. J. B. Warmack's L. P. Weaver 1, NW SE SW 17-14s-21w, pumped 6 barrels from Nacatoch sand, Upper Cretaceous 1192-1200 feet, 13-gravity, completed 3-25-51, TD 1202.

ARKANSAS—NEW OIL PAYS

Union County, New London, North field. Murphy Corporation's Burgess 1, C N½ NE NW 33-17s-12w, pumped 50 barrels and 60 barrels water from Cotton Valley sand, Jurassic 4296-4301 feet, 20-gravity, completed 4-30-51, TD-5035.

Schuler, East field. Curtis Kinard's Burns 1, C SW NE SW 13-18s-17w, flowed 102 barrels and 10 barrels water from Smackover lime, Jurassic 7610-7614 feet, 10/64-inch, completed 4-26-51, TD 7700.

Wilks field. C. H. Murphy & Company's Gottschall 1, NE SE 3-18s-18w, flowed 123 barrels from Cotton Valley sand, Jurassic 6769-6777 feet, 14/64-inch, completed 4-30-51, TD 7894.

ARKANSAS—OIL FIELD EXTENSION

Union County, Urbana, West field. Roberts Petroleum, Incorporated's Hill 1, C SW SW SW 5-18s-13w, ½-mile northwest extension, flowed 9 barrels from Meakin sand, Upper Cretaceous 2528-2538 feet, 10/64-inch, completed 4-9-51, TD 3020.

CALIFORNIA—NEW OIL FIELDS

Kern County. California Exploration Company & MacMillan Petroleum Corporation's Porter 28-2, in 28-30s-29e, flowed 95 barrels from Santa Margarita sand, Upper Miocene 3742-4158 feet, 21.1-gravity, 12/64-inch, completed 3-28-51, TD 4159.

Los Angeles County, Newhall-Townsite field. Talisman Oil Company's Braille 1, Section 1-3n-16w, pumped 53 barrels from Pliocene 3159-3178 feet, completed 3-27-51, TD 3196.

CALIFORNIA—NEW OIL PAY

Kern County, Salt Creek field. Carneros Oil Company's Anderson 2-1 (OWWO), in 19-29s-21e, flowed 200 barrels from Phacoides sand, Miocene 2423-2455 feet, 17.9-gravity, 14/64-inch, completed 4-22-51, TD 2456.

CALIFORNIA—OIL FIELD EXTENSIONS

Monterey County, San Ardo field. Jergins Oil Company's Rosenberg 102-2, in 2-23s-10e, ½-mile northeast extension, pumped 200 barrels from Orradre sand, Miocene 2571-2651 feet, 12-gravity, completed 4-20-51, TD 2671.

Santa Barbara County, Cuyama, South field. Richfield Oil Corporation's Cox 35-5, in 5-9n-26w, ½-mile east extension, flowed 222 barrels from Hibberd sand, Miocene 5864-5896 feet, 37.3-gravity, 15/64-inch, completed 4-8-51, TD 5988.

COLORADO—NEW OIL FIELD

Logan County, Graylin field. British American Oil Producing Company's Monroe 1, NE NE SW 7-8n-53w, pumped 135 barrels from Dakota "D" sand, Upper Cretaceous 4888-4894 feet, ⅜-inch, TD 5525.

COLORADO—NEW GAS PAY

Moffat County, Thornburg field. Continental Oil Company's W. A. Lewin 1, SE NE SE 17-3n-91w, flowed 13 million from Weber sand, Pennsylvanian 4005-4326 feet, completed 3-31-51, TD 7348.

ILLINOIS—NEW OIL FIELDS

Clinton County, Frogtown, North field. Gulf Oil Corporation's Frank Warnecke 1, NE NE NW 6-2n-3w, flowed 165 barrels from St. Louis lime, Mississippian 1195-1209 feet, completed 4-17-51, TD 2340.

Hamilton County, Blairsville, West field. G. C. Schoonmaker's R. Thompson 1, NW SW 18-4s-7e, flowed 490 barrels from McClosky lime, Mississippian 3416-3420 feet, completed 5-1-51, TD 3422.

ILLINOIS—NEW OIL PAYS

Clinton County, Frogtown, North field. E. J. Gildschmidt's Jaske Community 1, NE SE 1-2n-4w, ½-mile south of production, flowed 440 barrels and 50 barrels water from Devonian-Silurian lime, Devonian-Silurian 2264-2268 feet, completed 4-17-51, TD 2280.

Wabash County, Keensburg, South field. White & Vickery's Garst 1, SE SE SW 27-2s-13w, pumped 360 barrels from Cypress sand, Mississippian 2404-2416 feet, completed 4-24-51, TD 2416.

Wayne County, Ellery, West field. Skiles Oil Corporation's E. H. O'Daniel 1, NW SW NE 26-2s-9e, pumped 50 barrels from Aux Vases sand, Mississippian 3230-3236 feet, completed 4-24-51, TD 3238.

Locust Grove field. J. W. Rudy's C. Denny-Bunting 1, NW SE NW 32-1n-9e, ½-mile southeast of production, pumped 54 barrels from Aux Vases sand, Mississippian 3218-3225 feet, completed 4-3-51, TD 3229.

INDIANA—NEW OIL FIELDS

Gibson County. Tuley & Carter's M. Witherspoon 1, SW SE NW 20-3s-11w, pumped 10 barrels from Benoist sand, Mississippian 2328-2339 feet, TD 2591.

Monroe County. Frederick B. Cline's Easter 1, NE SW SE 33-7n-1e, pumped 15 barrels from Trenton lime, Ordovician 1740-1743 feet, TD 1743.

Sullivan County. Lyman Ormiston's Homer & Stella Street 1, NE NW SE 33-8n-10w, pumped 20 barrels from Pennsylvanian sand, Pennsylvanian 775-787 feet, TD 787.

Vanderburgh County. A. J. Slagter, Jr.'s George J. Kissell 1, SW SW NE 30-4s-10w, pumped 35 barrels from Jackson sand, Mississippian 1963-1988 feet, TD 2389.

KANSAS—NEW OIL FIELDS

Barton County, Larkin field. Anschutz Drilling Company's Reidl 1, CEL 10-17s-14w, pumped 873 barrels from Lansing-KC lime, Pennsylvanian 3280-3285 feet, TD 3484.

Unnamed field. Sohio Petroleum Company's Schrepel 1, NE NW SW 19-18s-11w, flowed 343 barrels from Lansing-KC lime, Pennsylvanian 3103-3108 feet, ⅜-inch, TD 3486.

Werner-Robl, Northwest field. W. L. Hartman's I. E. Robl 1, NW NW SE 24-19s-12w, pumped 190 barrels from Lansing-KC lime, Pennsylvanian 3092-3100 feet, TD 3413.

Butler County. Rex and Morris Drilling Company's Johnson 1, SE SE NW 29-25s-4e, pumped 35 barrels from Viola lime, Ordovician 2700-2702 feet, 44.7-gravity, TD 2702.

Graham County, Law field. Harry Gore's Law 1, NE NE SE 34-9s-23w, pumped 537 barrels from Lansing-KC lime, Pennsylvanian 3922-3934 feet, 38-gravity, TD 4218.

Hodgeman County, Purdyville field. I. W. Siegel's Schraeder 1, NW SE NW 3-24s-24w, potential 1549 barrels from Mississippi dolomite, Mississippian 4663-4683 feet, TD 4683.

Meade County, Novinger field. Columbian Fuel Corporation and United Producing Company's Novinger 1, C NW NW 26-33s-30w, pumped 66 barrels from Mississippi dolomite, Mississippian 5803-5832 feet, 40-gravity, TD 6638.

Phillips County, Huffstutter, Northeast field. B&R Drilling Company's Babcock 2, NW NE NW 27-1s-8w, pumped 2 barrels from Lansing-KC lime, Pennsylvanian 3340-3349 feet, TD 3440.

Stuttgart, South field. Westgate-Greenland Oil Company's Ehm 1, NW NW SE 23-3s-19w, pumped 37 barrels from Lansing-KC lime, Pennsylvanian 3130-3139 feet, TD 3488.

Rooks County, Rogers field. Nadel & Gussman's Rogers 1, NE NE NW 23-10s-20w, potential 2664 barrels from Arbuckle lime, Ordovician 3772-3779 feet, TD 3779.

KANSAS—NEW OIL PAYS

Rice County, Geneseo field. J. C. Dozier's Wood 1, NW NE SW 7-18s-7w, pumped 18 barrels from Lansing-KC lime, Pennsylvanian 3198-3216 feet, TD 3300.

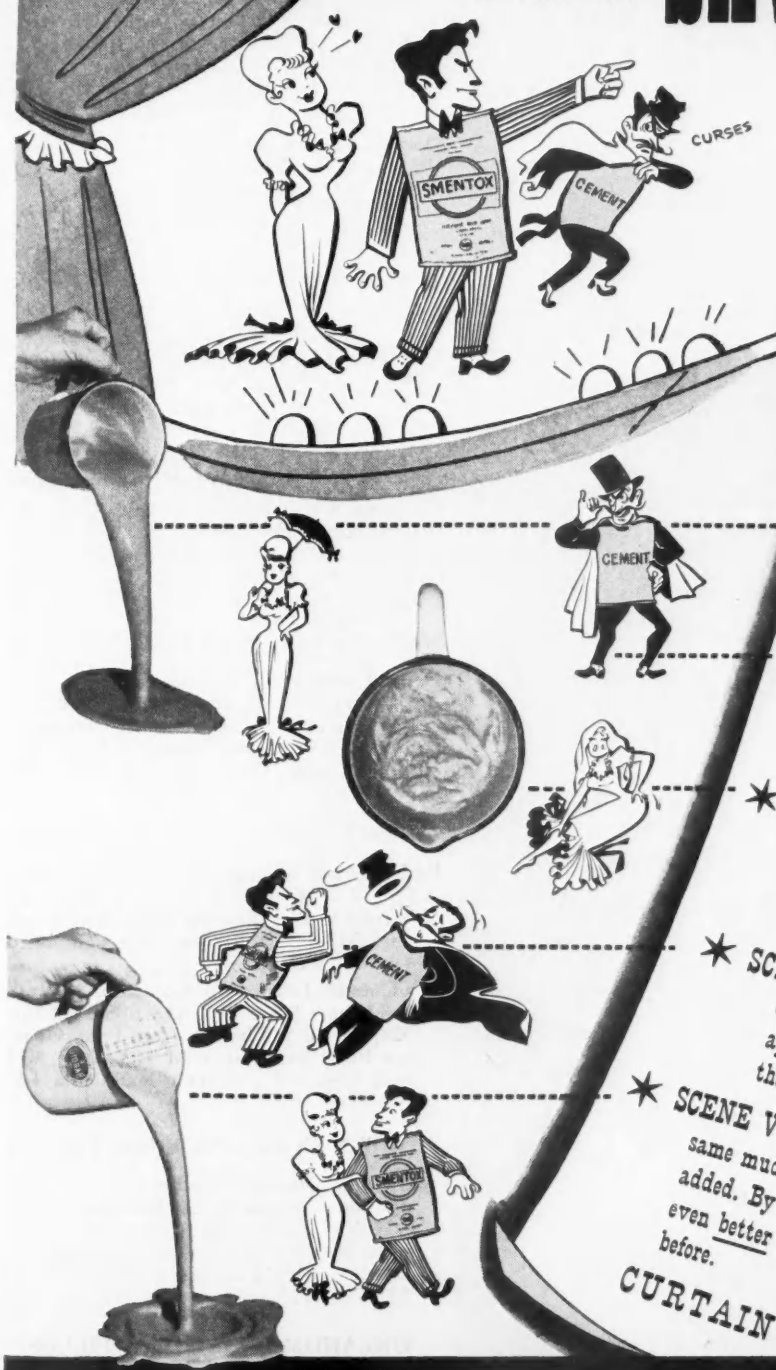
Stafford County, Duggan field. North American Producing Company's Hullman 1, SW SW SE 30-21s-11w, pumped 282 barrels from Simpson sand, Ordovician 3503-3514 feet, TD 3514.

KENTUCKY—NEW OIL FIELD

Daviess County. C. Morburger & J. Anton's Cox 1, in 6-P-28, pumped 42 barrels from McClosky lime, Mississippian 1817-1820 feet, TD 1821.

DON'T THROW OUT CEMENT-CUT MUD—

—it can be SAVED



A "DRAYMA" IN 5 SCENES

Dramatis Personae

OUR HEROINE— Well-behaved Drilling Mud.

THE VILLAIN— Cement.

OUR HERO— **SMENTOX**

★ **SCENE I** Here is the original mud—perfectly good drilling mud—going quietly about its business UNTIL * *

★ **SCENE II** — it meets Cement (that dirty villain) and becomes contaminated.

★ **SCENE III** Look at the poor stuff now—plastic, unpumpable, apparently ruined and about to be thrown out—

★ **SCENE IV** — when along comes SMENTOX (loud applause) who knocks out the villain, Cement.

★ **SCENE V** Now look at the same mud with SMENTOX added. By Gad, sir—it's even better than it was before.

CURTAIN

Baroid

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES 12 · TULSA 3 · HOUSTON 2

COMPLETE DRILLING MUD SERVICE

KENTUCKY—OIL FIELD EXTENSION

Henderson County, Zion field. J. C. Ellis, Carl Morrison & Wallace Damron's J. L. Griffin 1-P, C SE NW 1-P-25, ¾-mile northeast extension, pumped 51 barrels and 76 barrels water from O'Hara lime, Lower Mississippian 2193-2198 feet and McClosky lime, Lower Mississippian 2227-2242 feet, TD 2251.

NORTH LOUISIANA—NEW OIL FIELD

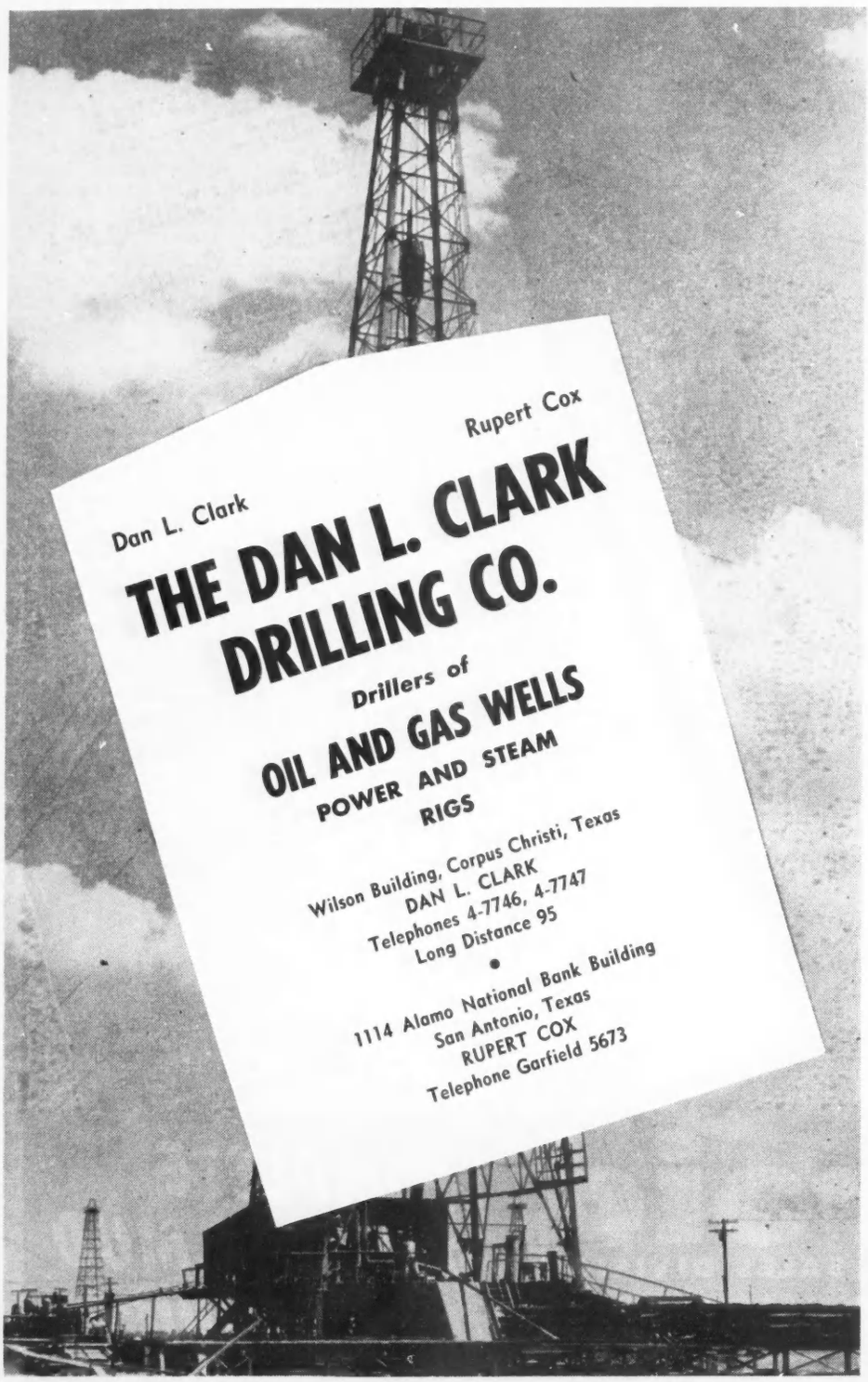
Caddo Parish. Burnham & Browning's Robert B. Williamson 1, (OWWO), SW SW 9-19n-16w, pumped 34 barrels and 7 barrels water from Goodland lime, Lower Cretaceous 2298-2318 feet, 36-gravity, completed 4-25-51, TD 8389.

NORTH LOUISIANA—OIL FIELD EXTENSION

La Salle Parish, Catahoula Lake, West field. J. S. Michael Company's Nebo Oil Company 1-C, in 3-6n-3e, ¾-mile west extension, pumped 5 barrels and 35 barrels water from Wilcox sand, Eocene 3728-3736 feet, completed 4-10-51, TD 4502.

NORTH LOUISIANA—NEW GAS PAY

Lincoln Parish, Simsboro field. Murphy Corporation & Pan-Am Southern Oil Company's Givens 2, in 12-17n-4w, 1 mile east of production, flowed 4.4 million from Hill sand, Lower Cretaceous 5436-5465 feet, 15/64-inch, completed 4-5-51, TD 6998.



SOUTH LOUISIANA—NEW OIL PAY

Ascension Parish, Darrow field. Temple Hargrove & The Texas Company's Guiliuzzo Unit 1-1, in 49-10s-2e, flowed 226 barrels from 9899-9911 feet, 37.5-gravity, 9/64-inch, completed 4-19-51, TD 11,550.

SOUTH LOUISIANA—OIL FIELD EXTENSION

Acadia Parish, Crowley field. Warren Oil Corporation's Elmer E. Jeffers 1, in 10-10s-1e, ½-mile east extension, flowed 453 barrels from Baronet sand, Miocene 9819-9824 feet, 37.7-gravity, 10/64-inch, completed 4-26-51, TD 11,250.

MICHIGAN—NEW OIL FIELD

Oceana County, Shelby field. Gulf Refining Company's Ruckel 1, NE SW NW 18-14n-18w, pumped 75 barrels from Traverse lime, Devonian 1735-1763 feet, TD 1763.

MISSISSIPPI—NEW DISTILLATE PAY

Lamar County, Baxterville field. Gulf et al's Virgil Davis et al G-2, in 7-1n-16w, flowed 19 barrels and 3.5 million from Wilcox sand, Eocene 5074-5190 feet, 57.6-gravity, 22/64-inch, completed 4-11-51, TD 5252.

NEBRASKA—NEW OIL FIELD

Cheyenne County, Marlow field. Ohio Oil Company's William A. Sparks 1, NE SE NE 29-15n-49w, pumped 30 barrels from 2nd Dakota sand, Lower Cretaceous, completed 4-19-51, TD 4710.

NEBRASKA—GAS FIELD EXTENSION

Deuel County, Big Springs field. Superior Oil Company's Zimmerman 1, NW NW NW 30-13n-42w, 1 mile south extension, flowed 5.5 million from Dakota "D" sand, Upper Cretaceous, ¾-inch, TD 3340.

NEW MEXICO—NEW OIL FIELDS

Eddy County. George D. Riggs' Welch et al 1, SW NW SE 5-21s-27e, pumped 50 barrels and 125 barrels water from Yates sand 543-545 feet, 20-gravity, completed 4-10-51, TD 551.

Lea County. Lawton Oil Company & W. L. Goldston's State A-1, C SE SE 30-15s-33e, flowed 336 barrels from Pennsylvanian lime, Pennsylvanian 10,587-10, 617 feet, 42-gravity, ¼-inch, completed 4-2-51, TD 10,619.

NEW MEXICO—NEW GAS FIELD

San Juan County. Southern Union Production Company's C. Robinson 1, SE NW NW 22-28n-13w, flowed 0.1-million from Pictured Cliffs sand, Upper Cretaceous 1649-1725 feet, completed 3-21-51, TD 1725.

OKLAHOMA—NEW OIL FIELDS

Comanche County, Apache, South field. Tide Water Associated Oil Company's Tribal 1, SE SE SW 3-4n-11w, flowed 20 barrels from Simpson sand, Ordovician 1564-1576 feet, 28-gravity, 18/64-inch, TD 1581.

Cotton County, Essaquanahdale, West field. Ted A. Norwood et al's Taylor 1, NE NW NW 29-3s-11w, pumped 25 barrels and 25 barrels water from Pennsylvanian sand, Pennsylvanian 1494-1500 feet, TD 1600.

Our 19th Year *as an integrated geophysical research organization brings assurance of accurate interpretation of data obtained by experienced, closely supervised crews, working with the most modern instruments and techniques. Seismic Explorations, Incorporated, 1007 South Shepherd, Houston, Texas.*

Jefferson County. H. B. Dudley & C. Y Gorman's Wilmer D. Seay B-1, SE SE SW 20-6s-5w, pumped 74 barrels from "Seay" sand, Ordovician 1737-1746 feet, 30.1-gravity, TD 1747.

Kay County, Northwest Doe Creek. Midstates Oil Corporation's H. I. Harris 1, C NE NE NW 20-28n-2w, flowed 469 barrels from 1st Wilcox sand, Ordovician 4613-4628 feet, and Simpson dolomite, Ordovician 4628-4656 feet, 46-gravity ¾-inch, TD 5000.

Murray County. C. J. Hobson & R. S. Brown's Sadler 1, SW SW SW 20-1n-2e, pumped 25 barrels from Pennsylvanian sand, Pennsylvanian 1950-1978 feet, 22-gravity, TD 2110.

Osage County, East Doga field. Republic Natural Gas Company's West Fairfax 1, NW NE SW 9-24n-5e, pumped 12 barrels from Skinner sand, Pennsylvanian 3124-3130 feet, TD 3155.

OKLAHOMA—NEW OIL PAY

Garvin County, Pauls Valley, West field. Gene Goff et al's Marie Rooke Bailey 1, SE SE NE 20-4n-1w, 1-mile northwest of production, pumped 130 barrels from Basal Detrital lime, Pennsylvanian 4648-4667 feet, 31-gravity, TD 5001.

OKLAHOMA—OIL FIELD EXTENSIONS

Creek County, Cushing, East field. H. Waggoner & Company's Davidson 1, NW SE SE 17-19n-8e, ½-mile east extension, flowed 40 barrels from Red Fork sand, Pennsylvanian 2522-2546 feet, 12/64-inch, TD 2638.

Lincoln County, Tryon, Northwest field. Zephyr Petroleum Company & Alpha Petroleum Corporation's Charles W. Gray 1, SE SE NW 3-17n-3e, ½-mile north extension, flowed 238 barrels from Senora (Red Fork) sand, Pennsylvanian 4134-4151 feet, TD 4151.

Noble County, Ceres, South field. J. W. Marshall Pipe & Supply Company's Hall 1, SW NW NE 32-24n-1e, ½-mile northeast extension, flowed 91 barrels from Burbank sand, Pennsylvanian 4265-4302 feet, 12/64-inch, TD 4398.

Lucien field. Bay Petroleum Corporation's Jerome et al 1, SE SE SW 15-20n-2w, ½-mile northeast extension, pumped 25 barrels and 5 barrels water from Perry sand, Pennsylvanian 3718-3730 feet, TD 5237.

Pottawatomie County, McComb, South field. Stanolind Oil & Gas Company's B. J. Badger 1, SE SE SW 3-7n-3e, southeast extension, flowed 198 barrels from Bois D'Arc lime, Devonian 4515-4530 feet, 35-gravity, 14/64-inch, TD 4565.

OKLAHOMA—DISTILLATE FIELD EXTENSION

Beaver County, Light field. J. M. Huber Corporation's Wallace 1, C SW NW 15-6n-21e, ½-mile south extension, flowed 81 barrels and 12.5-million from Morrow sand, Pennsylvanian 5973-6004 feet, 59.4-gravity, TD 6292.

OKLAHOMA—NEW GAS PAY

Comanche County, Apache, South field. Tide Water's Myers 1, NE NE NW 10-4n-11w, flowed 1.7-million from Basal Detrital lime, Pennsylvanian 3440-3480 feet, ¾-inch, TD 4071.

TEXAS DISTRICT 1—NEW OIL FIELDS

Atascosa County, "Pruitt" field. Humble Oil & Refining Company's E. J. Pruitt C-1, Fabrious Reynolds Survey, pumped 12 barrels from Navarro sand, Upper Cretaceous 4930-4964 feet, 38.2-gravity, completed 4-1-51, TD 5066.

Caldwell County. A. W. Phillips' W. J. Richards et al 1, Andrew Churchill Survey, pumped 30 barrels and 15 barrels water from Austin chalk, Upper Cretaceous 1615-1747 feet, completed 4-25-51, TD 1747.

TEXAS DISTRICT 1—NEW GAS FIELD

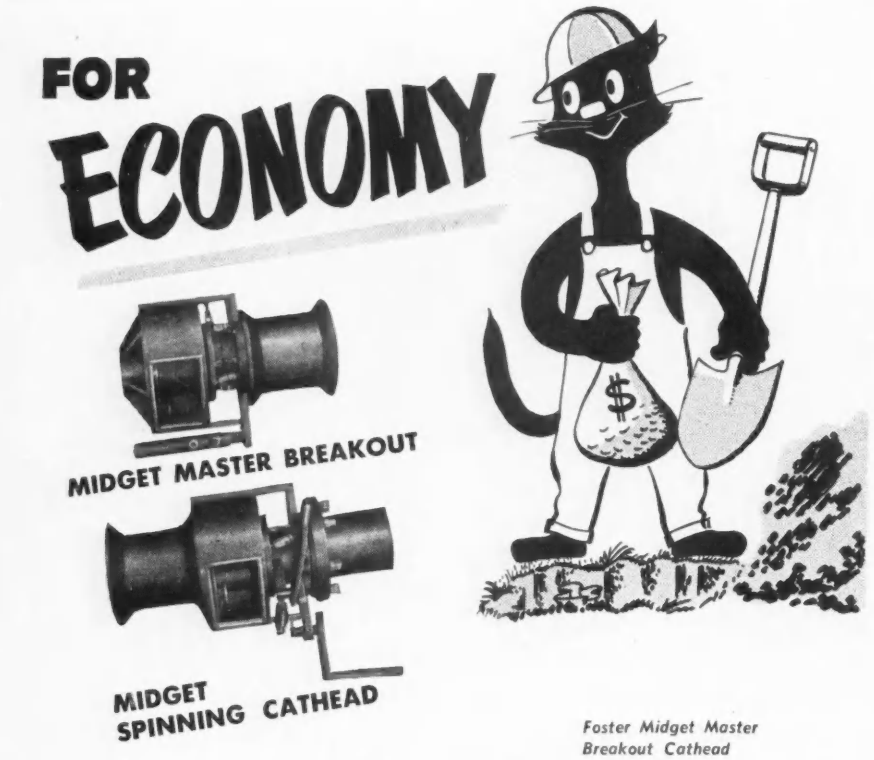
Frio County, "Doering, West" field. Humble's Humble-Marrs McLean 1-B, BS&F Survey, flowed 2.3-million from Navarro sand, Upper Cretaceous 4155-4170 feet, ¼-inch, completed 4-22-51, TD 4260.

TEXAS DISTRICT 1—GAS FIELD EXTENSION

Atascoa County, Charlotte field. Humble's Albert E. Beckman 1, William McFaddin Survey, ½-mile northeast extension, flowed 18-million from Navarro sand, Upper Cretaceous 4411-4426 feet, open, completed, 4-2-51, TD 5265.

TEXAS DISTRICT 2—NEW OIL PAYS

DeWitt County, Arneckeville field. Oil Drilling Company's O. A. Zengerle Unit 1-1, (OWWO), Mumford House Survey, flowed 91 barrels from Wilcox sand, Eocene 7656-7674 feet, 36-gravity, ⅛-



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Foster Midget Master Breakout Cathead

Friction clutch and small drum permit instant engagement without reducing lineshaft speed . . . no metal-to-metal impact . . . no brakes required . . . equipped with air or manual controls.

Foster Midget Spinning Cathead

Relieves operator of handling spinning line . . . pipe is spun up smoothly under low clutch pressures . . . plenty of power for tonging. Drum does not crawl when clutch is disengaged.

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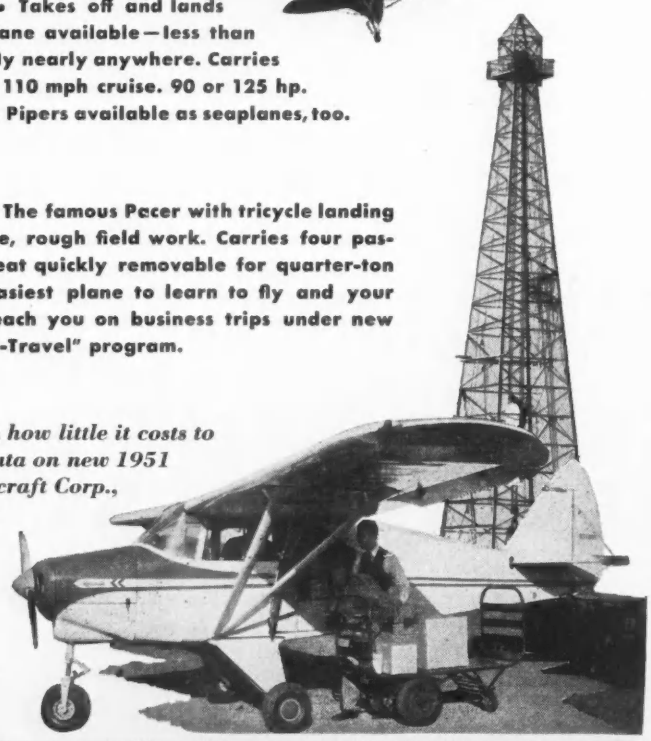

PIPER AIRCRAFT CORP., LOCK HAVEN, PA.

"TRAVEL FASTER, CHEAPER BY PIPER"

inch, completed 3-22-51, TD 7692.

Goliad County, Berclair field. Kirkpatrick & Coates' Terrell 11, Sampson McTornall Survey, pumped 22 barrels from Frio "A" sand, Oligocene 2223-2235 feet, 21-gravity, completed 3-6-51, TD 3212.

Cabeza Creek field. Continental's J. E. Pettus et al 34, Sebastiano Vela Survey, ¾-mile northwest of production, flowed 122 barrels from Slick (Wilcox) sand, Eocene 7550-7564 feet, 41-gravity, 10/64-inch, completed 3-14-51, TD 7794.

Jackson County, Lolita field. Abe Seibel's Ware-Kelso Unit 1-A, I&GN Survey, flowed 46 barrels from 6301-6303 feet, 39.3-gravity, 5/64-inch, completed 4-15-51, TD 8085.

Karnes County, Hobson field. Bill Forney & Charles Winn's Emil Swize 1, Don Erasmo Seguin Grant, flowed 162 barrels from Reklaw sand, Eocene 3954-3956 feet, 32.1-gravity, ⅛-inch, completed 4-28-51, TD 4047.

Live Oak County, North Karon field. Tide Water's Hicks Williams 1, F. G. Hines Survey, flowed 92 barrels from Lower Luling sand, Eocene 7278-7280 feet, 38.4-gravity, 7/64-inch, completed 4-2-51, TD 7802.

Refugio County, Boehm field. A. O. Morgan's F. J. Boehm 2, (OWDD), Section 13, Johnson & Pugh Subdivision, Bonnie View Ranch, Esteban Lopez Survey, flowed 26 barrels from 5334-5337 feet, 43-gravity, 9/64-inch, completed 4-23-51, TD 6854.

TEXAS DISTRICT 2—OIL FIELD EXTENSION

Goliad County, Boyce field. Sunray Oil Corporation's A. M. Albrecht 2-B, CCSD&RGNG Survey, ⅔-mile southwest extension, flowed 5.5-million from Slick (Wilcox) sand, Eocene 7500-7530 feet, and 64 barrels from Luling (Wilcox) sand, Eocene 7626-7647 feet, 32.3-gravity, ⅛-inch, completed 4-15-51, TD 7769.

TEXAS DISTRICT 2—NEW GAS PAY

Jackson County, Cordele, West field. H. J. Porter et al's Alma Traylor 1, F. Adam Survey, not gauged from 2442-2446 feet, completed 2-20-51, TD 3310.

TEXAS DISTRICT 2—GAS FIELD EXTENSION

Victoria County, Cologne field. Fidelity Oil & Royalty Company's Leona Reeves 1, J. M. Cobarrubias Grant, ½-mile east extension, not gauged from Frio sand Oligocene 4008-4020 feet, and Vicksburg sand, Oligocene 4735-4743 feet, completed 3-15-51, TD 5026.

TEXAS DISTRICT 3—NEW OIL FIELDS

Austin County. H. L. Hawkin's A. E. Mewis 1, J. P. Stephenson Survey, flowed 54 barrels from 10,455-10,480 feet, 40.5-gravity, ½-inch, completed 4-26-51, TD 11,000.

Hardin County. Sun Oil Company's Dishman-Lucas 1, Section 4, Isaac Bridge Survey, flowed 196 barrels from 9828-9843 feet, 33.7-gravity, 8/64-inch, completed 4-10-51, TD 11,025.

Liberty County. Gulf's Partlow 1, William Duncan Survey, flowed 223 barrels from 8700-8722 feet, 34.6-gravity, 10/64-inch, completed 4-24-51, TD 9000.

Wharton County. F. William Carr's Duffy 2, A. T. Smith Survey, flowed 133 barrels from 5636-5639 feet, 29.1-grav-

ity, 10/64-inch, completed 4-12-51, TD 5910.

TEXAS DISTRICT 3—NEW OIL PAYS

Harris County, Fairbanks field. Rowan Oil Company's Clark W. Henry et al 1, J. M. Dement Survey, flowed 28 barrels from Yegua sand, Eocene 6519-6529 feet, completed 4-18-51, TD 7715.

Liberty County, Moss Bluff field. British American's McFaddin et al 6, J. McFaddin Survey, flowed 127 barrels from 5648-5660 feet, 33.8-gravity, 8/64-inch completed 4-23-51, TD 6280.

TEXAS DISTRICT 3—NEW DISTILLATE FIELDS

Colorado County, Englehart, East field. Houston Oil Company's I. V. & H. B. Duncan 1, James Ross Survey, flowed 22 barrels and 0.7-million from Wilcox sand, Eocene 9316-9377 feet, completed 4-6-51, TD 9597.

Jefferson County. Meredith, Clegg & Hunt et al's Weisse et al 1, George W. Grammier Survey, flowed 59 barrels and 20-million from Frio sand, Oligocene 12,631-12,725 feet, open, completed 3-16-51, TD 13,353. Deepest production on Texas Gulf Coast.

TEXAS DISTRICT 3—NEW GAS FIELDS

Fort Bend County. Goldston Oil Corporation's Steffek 1, A. Hodge Survey, flowed 4.5-million from Frio sand, Oligocene 5070-5090 feet, TD 6700.

Wharton County. Republic Natural Gas & Charles H. Osmond's Earl 1, Henry Mills Survey, flowed 40-million from Frio sand, Oligocene 4575-4581 feet, open, completed 4-20-51, TD 5210.

TEXAS DISTRICT 3—NEW GAS PAY

Wharton County, Un-named field. William Carr's Duffy 1, A. T. Smith Survey, flowed 30-million from 5462-5484 feet, open, completed 4-26-51, TD 5538.

TEXAS DISTRICT 3—GAS FIELD EXTENSION

Wharton County, North Louise field. Republic Natural Gas & Osmond's J. J. Hill 1, W. J. Godsey Survey, ½-mile south extension, flowed 18.8-million from Frio sand, Oligocene 4438-4442 feet, open, completed 4-16-51, TD 5250.

TEXAS DISTRICT 4—NEW OIL FIELDS

Brooks County. The Chicago Corporation's Brijido Ramirez 2, La Encantada & Encino del Pozo Grant, flowed 15 barrels from 4716-4723 feet, 40.6-gravity, 7/64-inch, completed 4-18-51, TD 5945.

Duval County, "Parilla" field. James Doughty et al's W. R. Peters 1, CCD Co. Survey, pumped 40 barrels from Cole sand, Eocene 2201-2220 feet, 24-gravity, completed 4-22-51, TD 2220.

Jim Hogg County. Sun's A. C. Jones 11, Agua Nueva de Abajo Grant, Juan Manuel Ramirez Survey, flowed 117 barrels from Hockley sand, Eocene 4574-4582 feet, 45.5-gravity, ⅛-inch, completed 4-13-51, TD 4610.

San Patricio County. Atlantic Refining Company's E. L. Roots 1, Block 22, John McKee Survey, flowed 47 barrels from Catahoula sand, Oligocene 3924-3934 feet, 23-gravity, 8/64-inch, completed 3-28-51, TD 5915.

TEXAS DISTRICT 4—NEW OIL PAYS

San Patricio County, Harvey field. La Gloria Corporation's Ray & Harvey 1,

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But--before we bore you. . . .

There's one BIG reason that
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And here's why it will pay you. . . .

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top personnel. . . .

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you'll become immersed. . . .

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In Tulsa --
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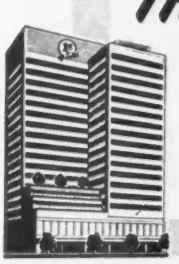

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MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Lot 8, Block 63, 5th Addition to Taft Farm Lands, ¾-mile northeast of production, flowed 124 barrels from 13-C sand, Oligocene 8716-8734 feet, 42.5-gravity, ⅛-inch, completed 5-1-51, TD 10,120.

Midway field. F. M. Boykin, Junior's A. W. Scrivner 1-A, Section "J" of G. H. Paul Subdivision of Coleman-Fulton Pasture Company Lands, flowed 76 barrels from 6615-6616 feet, 39-gravity, 1/7-inch, completed 4-17-51, TD 8702.

Plymouth field. Humble's Bevly 8, Lot 8, 4th Addition to Taft Farm Lands Subdivision, J. Fessenden Survey, flowed 70 barrels from 5864-5874 feet, 40.9-gravity, ⅛-inch, completed 4-20-51, TD 7502.

Sinton, North field. Plymouth Oil Company's R. H. Welder B-3 (OWDD), Section 80, Welder Ranch Subdivision, flowed 66 barrels from 5620-5630 feet, 34-gravity, completed 4-12-51, TD 6607.

TEXAS DISTRICT 4—OIL FIELD EXTENSION

Nueces County, Mustang Island field. Sunray's State Tract 461-1, State Tract 461, Corpus Christi Bay, ¾-mile south extension, flowed 151 barrels from Frio sand, Oligocene 7218-7234 feet, 42.7-gravity, 8/64-inch, completed 4-20-51, TD 8000.

TEXAS DISTRICT 4—NEW DISTILLATE FIELD

Aransas County. Union Producing Company's Virginia H. Tatton 4, John M. Shreve Survey, flowed ½ barrel and 0.7-million from 8701-8763 feet, ¼-inch, completed 4-19-51, TD 10,496.

TEXAS DISTRICT 4—DISTILLATE FIELD EXTENSION

Nueces County, Mustang Island field. Renwar Oil Corporation & Arkansas Fuel Oil Company's George Gay 1, A. B. Davis Survey, 1½-mile south extension, flowed 185 barrels and 9-million from Frio sand, Oligocene 7062-7082 feet, 63-gravity, open, completed 4-9-51, TD 8015.

TEXAS DISTRICT 4—NEW GAS FIELD

Nueces County. C. G. Classcock's Thomas Dix 1, Block 2, Banks Subdivision of Driscoll Ranch, flowed 28-million from 6550-6558 feet, open, completed 4-24-51, TD 7502.

TEXAS DISTRICT 4—GAS FIELD EXTENSION

Webb County, Moca field. The Texas Company's DCRC, NCT-94, H-1, Duval CSL Survey, ½-mile northeast extension, flowed 7.6-million from Yegua sand, Eocene 1760-1770 feet, open, completed 4-21-51, TD 3300.

TEXAS DISTRICT 5—NEW OIL PAY

Kaufman County, Ham-Gossett field. Eugene Talbert's J. M. Tuggle 1, E. D. Fitzgerald Survey, flowed 275 barrels from Hill sand, Lower Cretaceous 6225-6244 feet, 42-gravity, 11/64-inch, completed 4-18-51, TD 6400.

TEXAS DISTRICT 5—OIL FIELD EXTENSION

Grayson County, Mulder field. H. F. Gibson's G. P. Webb 1, J. D. McLeod Survey, ¾-mile northwest extension, flowed 384 barrels from Simpson sand, Ordovician 7561-7603 feet, 44-gravity, 14/64-inch, completed 4-9-51, TD 7603.

TEXAS DISTRICT 5—NEW DISTILLATE FIELD

Limestone County, "Oletha" field. The Texas Company's Lula Mason 1, Section 54, J. L. Chavert Survey, flowed 363 barrels and 23-million from Rodessa sand, Lower Cretaceous 6788-6804 feet, 57.4-gravity, open, completed 4-16-51, TD 8389.

TEXAS DISTRICT 6—NEW OIL FIELD

Anderson County. "McCrary field." Douglas A. McCrary's Southern Pine Lumber Company 1, T. N. Jones Survey, pumped 49 barrels and 15 barrels water from Woodbine sand, Upper Cretaceous 5274-5276 feet, 41.2-gravity, 10/64-inch, completed 4-21-51, TD 5300.

TEXAS DISTRICT 6—NEW OIL PAY

Harrison County, Woodlawn field. Hollandsworth Oil Company's Frank Davis Estate 3, R. W. Smith Survey, flowed 237 barrels from Upper Pettit Line, Lower Cretaceous 6467-6477 feet, 41-gravity, ¼-inch, completed 4-20-51, TD 6581.

TEXAS DISTRICT 6—OIL FIELD EXTENSION

Anderson County, Tennessee Colony field. Big Chief Drilling Company's I. M. Hughes 1, M. Rionda 2 League Grant, 1-mile north extension, not gauged from Upper Rodessa lime, Lower Cretaceous 8892-8900 feet, and flowed 216 barrels from Pettit lime, Lower Cretaceous 9669-9682 feet, ⅛-inch, completed 4-5-51, TD 9768.

TEXAS DISTRICT 6—NEW DISTILLATE FIELD

Anderson County, "Prairie Lake" field. Continental's Frank H. Carroll 1, J. I. Aguilera Grant, flowed 204 barrels and 3.3-million from Hill lime, Lower Cre-

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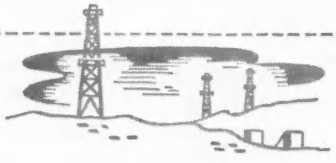

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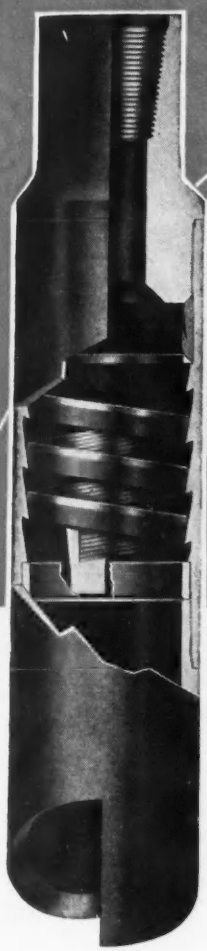

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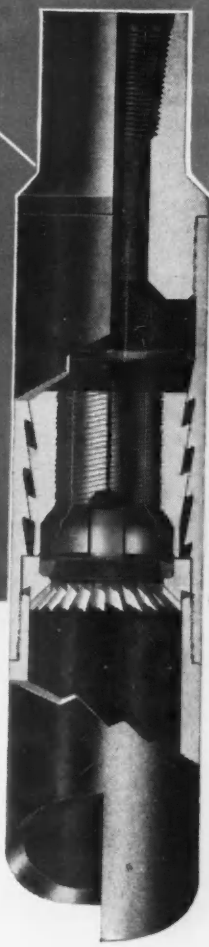

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taceous 8814-8824 feet, 56-gravity, 14/64-inch, completed 4-15-51, TD 9886.

TEXAS DISTRICT 7-C—NEW OIL FIELDS

Coke County, "Bloodworth 5700" field. Sun's H. L. Bloodworth 2, Section 462, Block 1-A, H&TC Survey, flowed 55 barrels from Strawn sand, Pennsylvanian 5664-5669 feet, 42.7-gravity, 2-inch, completed 4-4-51, TD 6660.

Irion County, "Tankersly Wolfcamp" field. George and Frank Frankel & Shell Oil Company's Rawls 1, Section 9, Cert. A-118, GC&SF Survey, flowed 135 barrels from Wolfcamp lime, Permian 5464-5494 feet, 38.8-gravity, 10/64-inch, completed 4-5-51, TD 7397.

Runnels County. Susan Petroleum Company's D. E. Pinegar 1, Section 10, Block F, BBB&C Survey, pumped 10 barrels from Fry sand, Pennsylvanian 4378-4388 feet, 39.8-gravity, completed 4-19-51, TD 4398.

Tom Green County. American Republics Corporation & Cities Service Oil Company's Mrs. J. V. Ketchum 1, John O. White Survey, pumped 19 barrels and 16 barrels water from Ellenburger lime, Ordovician 5687-5726 feet, 47.2-gravity, completed 4-9-51, TD 5738.

Upton County, "Flat Rock" field. Cities Service Oil Company & Continental's University AH-1, Section 29, Block 3, University Lands Survey, flowed 2044 barrels from Ellenburger dolomite, Ordovician 10,735-10,745 feet, 60.8-gravity, ¾-inch, completed 1-23-51, TD 11,285.

TEXAS DISTRICT 8—NEW OIL FIELDS

Kent County. Kewanee Oil Company's Oliver 1, Section 11, Block 1, H&GN Survey, flowed 604 barrels from Canyon Reef lime, Pennsylvanian 6376-6502 feet, 38.2-gravity, 36/64-inch, completed 4-13-51, TD 6722.

Midland County. The Texas Company's Clarence Scharbauer et al NCT-1B-1, Section 35, Block 40, T-2-S, T&P Survey, flowed 660 barrels from Strawn sand, Pennsylvanian 10,290-10,470 feet, 55.7-gravity, 24/64-inch, completed 4-18-51, TD 10,875.

Sterling County. Parochial Petroleum Company's Mrs. H. Bade 1, Section 22, Block 22, H&TC Survey, pumped 23 barrels from Queen sand, Permian 1097-1113 feet, 32-gravity, completed 4-29-51, TD 1113.

TEXAS DISTRICT 8—NEW OIL PAYS

Andrews County, Bedford field. Shell & Texas' Ratliff-Bedford 12, Section 4, Block 73, PSL Survey, flowed 626 barrels from Fusselman lime, Silurian 9702-9895 feet, 41.3-gravity, ½-inch, completed 4-29-51, TD 9895.

Ector County, Jordan field. Shell Oil Company's Connell C-3, Section 13, Block B-16, PSL Survey, flowed 1092 barrels from Fusselman lime, Silurian 7420-7461 feet, 43.3-gravity, ½-inch, completed 4-12-51, TD 7461.

Midland County, Driver field. James H. Snowden et al & Sergent & Rutter's Schrock 1-34, Section 34, Block 37, T-4-S, T&P Survey, 3-miles southeast of production, flowed 394 barrels from Spraberry sand, Pennsylvanian 7026-7075 feet, 39-gravity, ½-inch, completed 4-18-51, TD 7075.

Scurry County, Kelly-Snyder field. Standard Oil Company of Texas' G. E. Parks 19, Section 447, Block 97, H&TC Survey, flowed 209 barrels from Cisco sand, Pennsylvanian 6120-6202 feet, 41.5-gravity, 17/64-inch, completed 4-21-51, TD 6906.

TEXAS DISTRICT 8—OIL FIELD EXTENSIONS

Cochran County, Levelland field. Stephens Petroleum Company's Masten 1, Armstrong CSL Survey, 1¾-mile southwest extension, pumped 74 barrels from San Andres lime, Permian 4975-5004 feet, 24.5-gravity, completed 4-2-51, TD 5004.

Ector County, TXL field. Phillips Petroleum Company's Adobe 1, Section 38, Block 45 T-1-S, T&P Survey, 1-mile southeast extension, flowed 196 barrels from Clear Fork sand, Permian 5592-5600 feet, 38.8-gravity, ¼-inch, completed 4-14-51, TD 11,130.

WEST VIRGINIA—NEW GAS FIELD

Preston County. Orville Eberly and William Snee's S. F. Calvert 1, Portland District, flowed 0.7-million from Oriskany sand, Devonian 5367-5494 feet, open, TD 5494.

WYOMING—NEW OIL FIELD

Big Horn County, Bonanza, Northwest field. Sierra Nevada Oil Company's State 1, SW SW SW 16-49n-91w, pumped 200 barrels from Tensleep sand, Pennsylvanian 4281-4318 feet, 38-gravity, TD 4357.

WYOMING—OIL FIELD EXTENSION

Big Horn County, Bonanza field. Bonanza Oil Company's State 1, SE SE NW 36-49n-91w, 1-mile southeast extension, flowed 300 barrels from Tensleep sand, Pennsylvanian 2761-2821 feet, 1/32-inch, completed 4-14-51, TD 2835.

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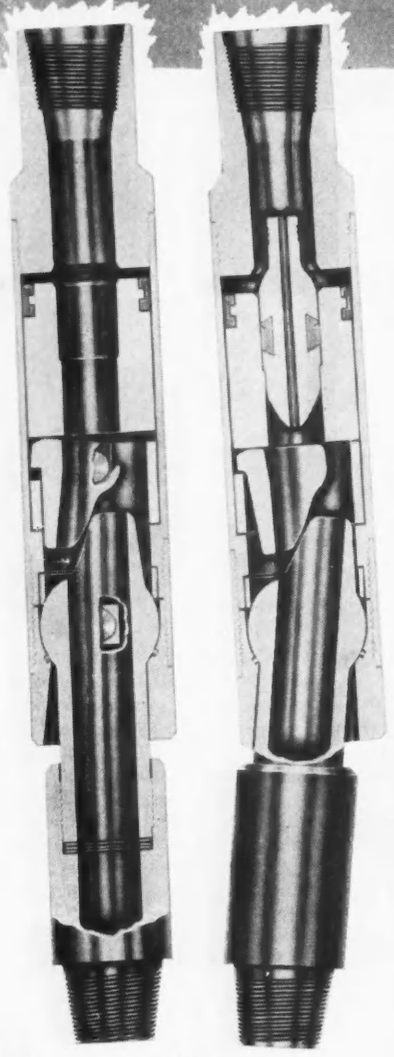

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Down the Hole Pressure Surges And Their Effect on Loss of Circulation

By W. C. GOINS, Jr., J. P. WEICHERT, J. L. BURBA, JR., D. D. DAWSON, JR.,
Gulf Oil Corporation, Houston
and A. J. TEPLITZ, Gulf Research and Development Company, Pittsburgh

LOST CIRCULATION, a frequent problem in rotary drilling, usually happens for a reason. This article reports on an investigation which showed that loss of circulation may easily be caused through the development of high surge pressures resulting from the improper handling of drill pipe or mud pumps. The paper was first presented at the spring meeting of the Southwestern District API Division of Production, in Beaumont, Texas.

BECAUSE of some particularly troublesome lost circulation difficulties experienced in a number of wells drilled in 1948, Gulf Oil Corporation assigned a group of engineers to the general study of the problem. The S. S. Perry 1 well at Peach Point had 45 separate losses of circulation, and it was decided that future operations in this area would be closely studied by the group.

Observations made during the course of drilling the S. S. Perry 2 revealed that there were 22 instances of loss of circulation; and that of these, three were associated with balling of the drill collars, six with downward movements of balled collars, five with downward pipe movements alone, and eight could not be associated with any apparent cause.

The methods through which this information was developed were: Pipe was usually pulled from the hole after each loss, and balling was observed at the surface. Otherwise, balling was detected from the drag occurring during pipe withdrawal to the casing or through the use of a pump-stroke recorder which showed a slowing of the mud pump as the ball formed. It was observed that development of balling coincided with pronounced increases in viscosity of the silicate mud used.

Pipe movements were shown to be an immediate cause of loss of circulation through the use of a pit-level recorder mounted on the rig floor. Although the purpose of this instrument was the detection of changes in mud volume, it was observed that vibrations of the drawworks while working the pipe shook the recording pen of the instrument so that each sharp movement could be identified. In the instances where working the pipe was associated with losses, charts similar to that of Figure 1 were found where the pit level decreased immediately after a pipe movement.

Another noteworthy observation was that in this field the hole almost invariably remained full after a loss of circulation, indicating that the formations in the area were capable of supporting the required hydrostatic pressures. This was true even though mud densities as high as 17.5 pounds per gallon had been used. Thus, the conclusion that pressures in excess of required hydrostatic pressure, caused by balling and pipe movements, were breaking down the formation and the resulting circulating pressures were sufficient to cause loss of circulation. It was believed that if the pressures could be kept near the required hydrostatic, then losses could be prevented.

It was evident that balling would substantially raise the pressure below the point of the ball and working of balled pipe would be expected to magnify this effect. If balling could be eliminated, high pressures from this source would be avoided.

Circulating pressures below the bit could be approximated and were known to be of a low order. No information was available as to the magnitude of pressure surges due to pipe movement, and a decision was made to investigate these to see if they were great enough to be responsible for breaking the formation down.

A sub was made to replace the bit in a drilling string and two pressure recorders were attached. The sub shown in Figure 2 contained two ⅝-inch ports through which circulation could be established, and the pressure recorders were either 7500 or 15,000 pounds per square inch drill-stem test recorders.

Tests were run inside casing in a number of wells to determine the effects of running and withdrawing pipe, spudding while pumping, and rapid opening of pumps to start cir-

TABLE 1

Table of Mud Properties and Pipe-Casing Combinations for Wells in Which Tests Were Made

Test No.	Type of Mud Used	Density (ppg)	Funnel Viscosity (Sec.)	Stormer Viscosity (Sec.)	Thixotrophy (Grams) Initial	Thixotrophy (Grams) 10 Min.	Casing Size (Inches)	O.D. Rubber Protectors (In.)	Annular Area (Sq. In.)	O.D. Drill Collars (In.)	Annular Area (Sq. In.)	Type Tool Joint	O.D. Tool Joint (In.)	Annular Area (Sq. In.)	O.D. Drill Pipe (In.)	Annular Area (Sq. In.)	Max. Recording Pressure of Gage Used, (psi.)
1	Caustic and quebracho thinned, fresh water mud	10.1	44	..	Slightly cement cut		7	4½	14.3	4½	14.3	....	3⅞	18.5	2⅞	23.8	15,000
2	Same	11.8	46	52	0	1	7⅝	4⅞	18.5	4½	21.2	....	4½	21.1	3½	27.4	7,500
3	Lime Treated Mud	16.2	82	63	4	7	7	None Used	....	4	17.6	....	3⅞	18.5	3½	20.3	15,000
4	Sodium Silicate Mud	14.0	49	....	2	8	9⅝	6⅝	27.1	6¼	30.9	....	5⅞	36.8	4½	46.2	7,500
5	Lime Treated Mud	11.8	43	27	0	0	9⅝	6¾	25.8	6¼	30.9	....	6	33.3	4½	46.2	15,000

culation. A typical pressure recorder chart from the tests is shown in Figure 3. Table 1 lists the mud properties and casing-drilling string combinations of the wells in which the tests were made. The work in each well was given a test number which is used to letter the corresponding curves in the figures which follow.

Figure 4 shows the surges due to running pipe at normal rates in five wells. The time required to drop 90 feet of stand in each test is shown on the graph. Pressure surges as high as 600 psi. at 8500 feet were found; the surges increased with depth.

A common experience in drilling is to find that a few tenths of a pound per gallon increase in mud density over that being carried will cause the formation to take fluid. It is of interest to evaluate the surges in terms of equivalent mud density. For instance, a 450 psi surge at 7500 feet is equivalent to a momentary increase in mud density of 1.1 ppg; 650 psi at 10,000 feet is equivalent to 1.2 ppg.

The results of dropping the pipe at approximately one-half normal or slightly slower rates are shown for some of the same wells in Figure 5. The time for dropping one stand ranged from 37 to 44 seconds and resulted in substantial decreases in the surges. With only one exception (Test 2) the surges were 100 psi or less at all depths where determinations were made.

Figure 6 shows the effect of varying rates of pipe movement on the surges at 8000 feet in Test 1. In this instance a Gulf Research pressure recorder was mounted inside the drill collar. Rate of pipe movement was calculated from the time for the middle joint of a 90-foot stand to drop through the rotary table; and is, therefore, approximately the maximum velocity of the pipe. These results show that the magnitude of the surges (which were lower because of pressure drop through the bit) is dependent on the rate of pipe movement.

Measurements were also made in several instances of the surges when plugged stands were run. This substantially increased the surges previously found. As an illustration, in Test 2 (Figure 4) the surge at 8000 feet was 250 psi when the stand was run in 16½ seconds. When a plugged string was run at this depth and rate the surge was 415 psi. In Test 1 the surge at 8500 feet was 650 psi when the stand was run in 14 seconds. With a plugged stand the surge was 800 psi. These two plugged-stand surges were equivalent to momentary in-

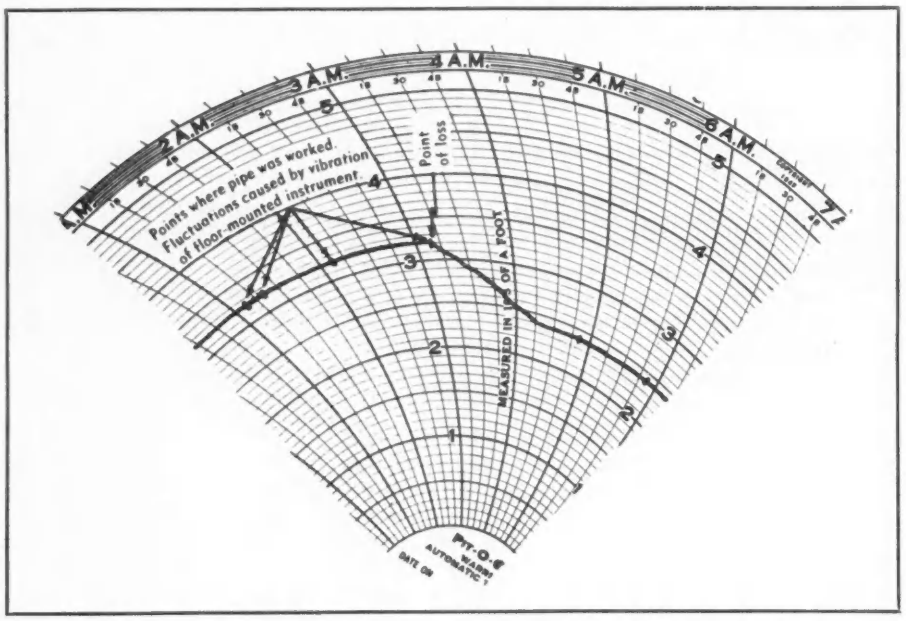


FIGURE 1. Chart from an automatic pit level measuring device.

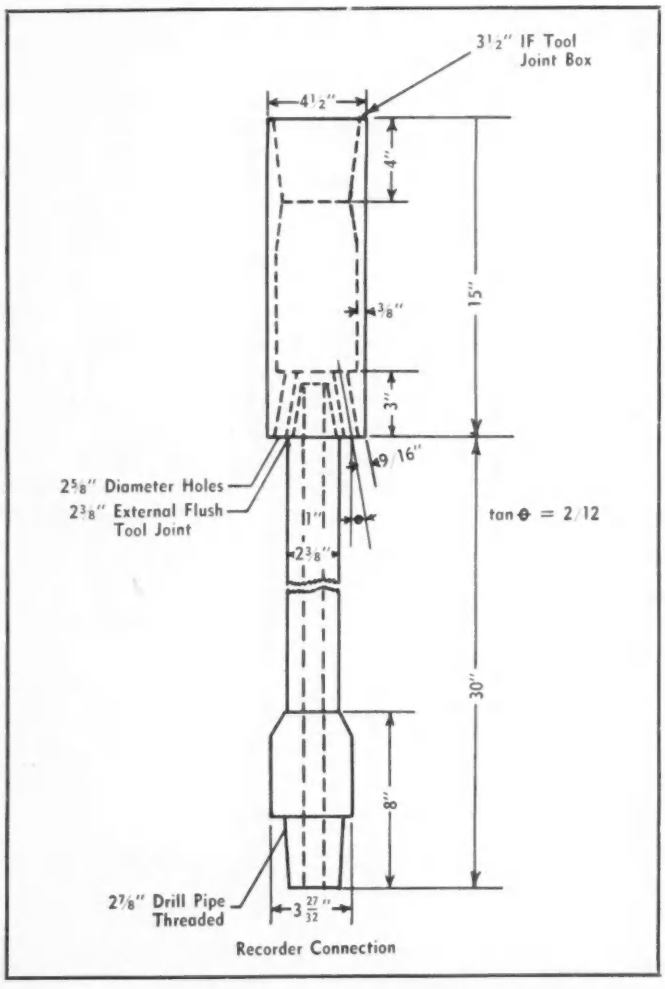
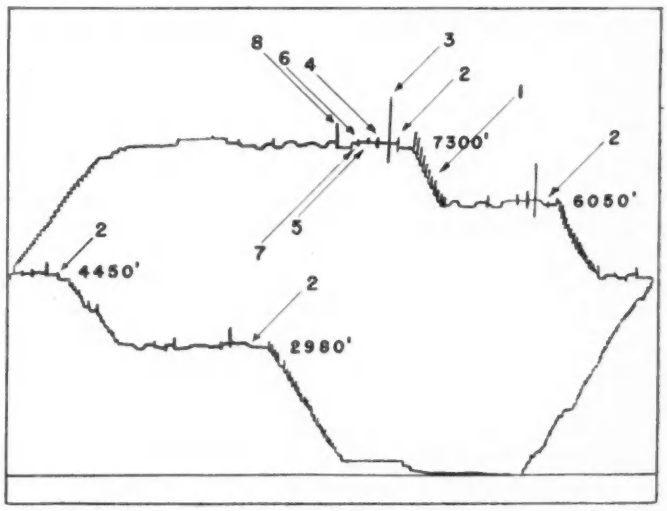


FIGURE 2. Pressure recorder sub.



KEY

1—Running pipe
2—Rapidly breaking circulation
3—Rapidly spudding 35 feet of pipe while circulating
4—Rapidly withdrawing 35 feet of pipe while circulating
5—Slowly spudding with 35 feet of pipe while circulating
6—Slowly withdrawing 35 feet of pipe while circulating
7—Circulation stopped
8—Rapidly running one 90-foot stand
9—Circulation started slowly

FIGURE 3. Pressure recorder chart from Test 4.

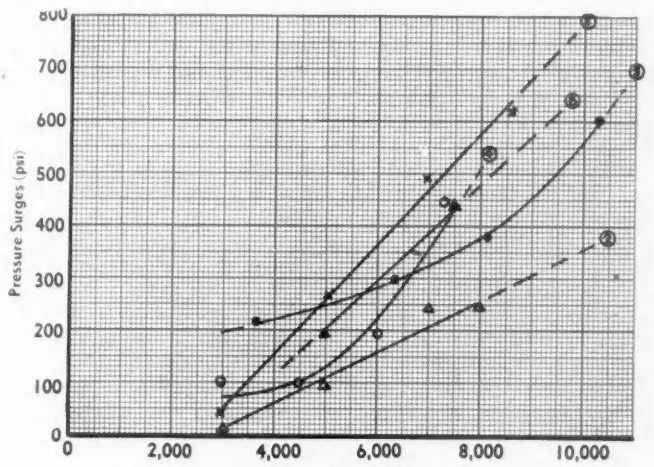
creases in mud density of 1.0 and 1.8 ppg, respectively.

Tests were also made to record the effect of spudding with 35 feet of kelly while pumping. These results are shown graphically in Figure 7. The time to drop the 35 feet of pipe varied for the different tests from 5 to 7½ seconds. In general, the surges were greater than for running pipe. The surge of 750 psi at 7500 feet in Test 5 is equivalent to a momentary increase in mud density of 1.9 ppg. For Test 3 at 7300 feet the surge of 860 psi is equivalent to 2.3 ppg of mud density. Spudding at slow rates resulted in substantially lower surges, as shown in Figure 8.

It was suspected that a surge pressure would result when pumps were started rapidly to break circulation. This was followed in Test 2 and the results are shown in Figure 9. At 8000 feet, when the pump was opened rapidly, a momentary pressure of 300 psi below the bit sub was recorded. This pressure decreased to 150 psi as soon as circulation was established. After approximately 15 minutes pumping, the circulating pressure had reduced to 50 psi. This decrease in circulating pressure was evidently due to a drop in apparent viscosity as the gels were broken out of the mud. The first surge was probably due to the force required to accelerate the long mud column from zero to the sustained circulating rate.

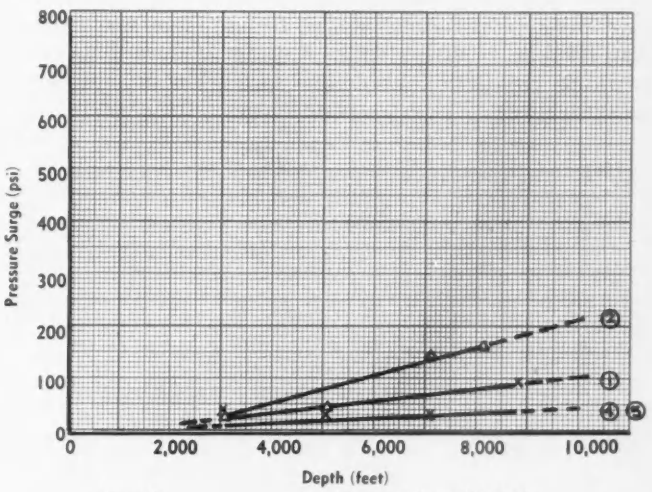
When the pumps were started slowly, the pressure rose only to the initial circulating pressure. The surge due to rapidly opening the pump was greater than the initial circulating pressure by 150 psi, or an equivalent momentary increase in mud density of 0.36 ppg.

Cannon[1] has shown the pressure reduction available during withdrawal of the pipe to be largely dependent on the gel strength of the mud, length of the pipe, and annular clearances. The Gulf tests employed muds with low gel strengths, consequently the swabbing effect was of a low order. Figure 10 shows the results obtained when stands were pulled at normal rates. Test 1, during which the mud was slightly cement cut and gelled, gave a pressure reduction of 350 psi at 8500 feet. The results from other tests were generally 100 psi or less at all depths. Withdrawing one stand in 60 to 80 seconds in Test 1 gave the



Test No.	Avg. Time to Drop 90′ of Pipe
1	14 seconds
2	16½ seconds
3	21 seconds
4	15½ seconds
5	11 seconds

FIGURE 4. Pressure surges due to rapidly running one stand of drill pipe.



Test No.	Avg. Time to Drop 90′ of Pipe
1	40 seconds
2	33 seconds
4*	38 seconds
5*	41 seconds

* All surges less than 50 psi

FIGURE 5. Pressure surges due to slowly running one stand of drill pipe.

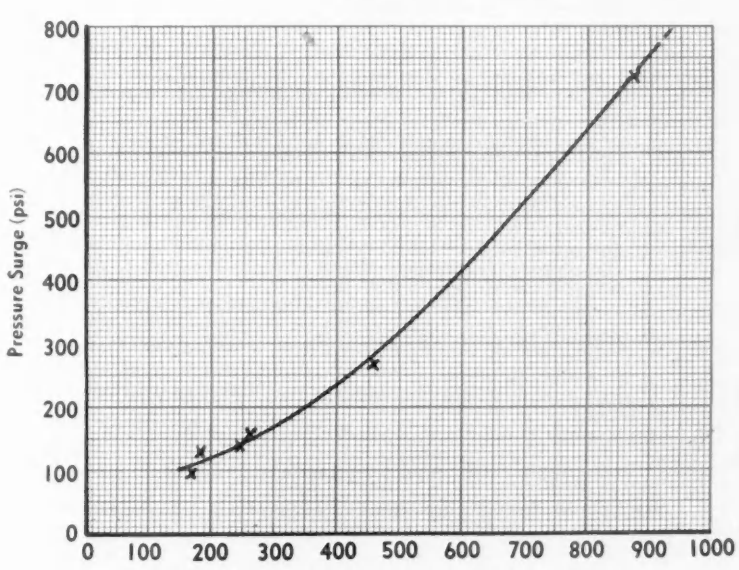
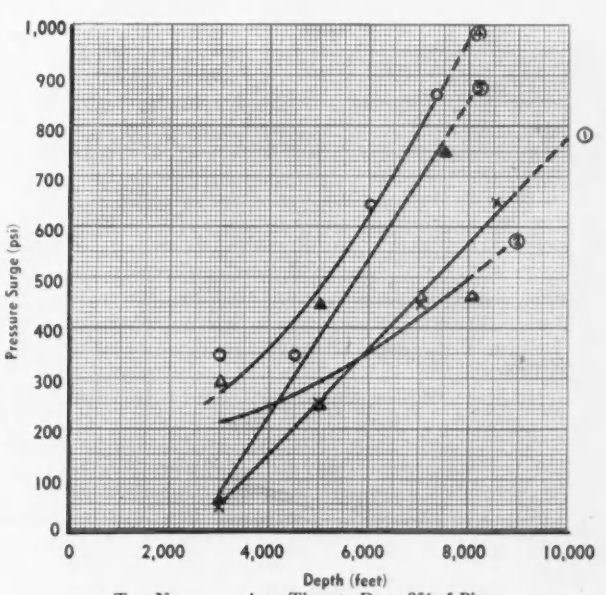


FIGURE 6. Variation of surge pressure with rate of pipe movement when running one stand in Test 1 at 8000 feet. (Gulf Research & Development Company pressure recorder mounted in drill collar. 6⅛-inch bit used.)



Test No.	Avg. Time to Drop 35′ of Pipe
1	7 seconds
2	7½ seconds
4	6 seconds
5	5 seconds

FIGURE 7. Pressure surges due to rapidly spudding 35 feet of pipe while circulating.

surges less than 50 psi at all depths. In the other tests, withdrawing pipe at 50 to 60 seconds per stand also gave pressure reductions of less than 50 psi.

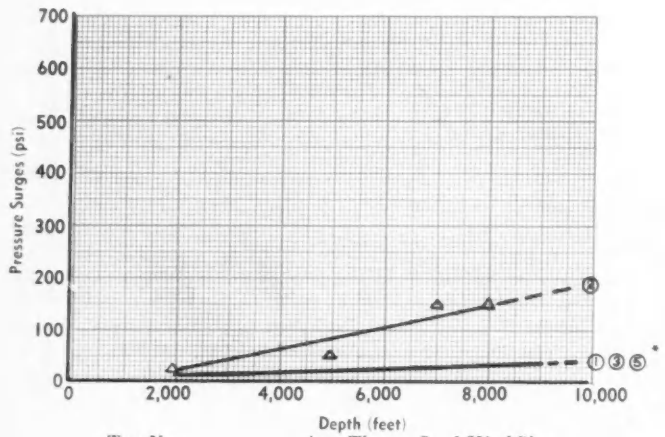
It was surprising to find that pressure reductions generally occurred when the pipe was withdrawn while pumping was in progress. Figure 11 shows the results of rapidly withdrawing 35 feet, or approximately the kelly length. These reductions were of a low order for the tests conducted, but were greater than the reductions due to withdrawing stands of pipe at maximum rates. Slow rates of withdrawal of pipe while pumping was in progress gave less than 50 psi reductions.

As a result of the tests it was found that running pipe at normal rates and rapidly spudding during circulation gave pressure surges of a high order that increased with depth. Rapidly breaking circulation also gave large pressure surges. These pressure surges are great enough, when imposed on hydrostatic pressure, frequently to be an immediate cause of loss of circulation. The surges may be avoided through slowed rates of pipe movement and slow breaking of circulation. While the effect of annular clearances and mud properties on these surges was not clearly shown, the tests were conducted under a variety of conditions which indicated that the effects found should be expected in almost any well.

Application of Results

Information developed was applied in the recent drilling of a well at Peach Point, the J. F. Perry, et al., Unit 1. Every effort was made to keep to a minimum the pressures above required hydrostatic. Three and one-half inch drill pipe with slim-hole tool joints and void of rubber protectors was used for drilling below the seven-inch casing, the interval which in previous wells had given the most difficulty. This increased the annular area over that with the pipe formerly used, and was expected to reduce annular circulating pressure. The viscosity and gels of the mud were kept as low as possible. Balling was eliminated through the use of a controlled rate of drilling and emulsion muds containing 10 percent diesel oil and sodium tall oil emulsifier. The pumps were opened slowly when circulation was started, and a controlled rate of pipe movement was initiated. This involved running pipe in the hole at a rate of 35 to 40 seconds per stand. Since a normal rate is from 14 to 15 seconds, this added less than one hour to trip time, even at a depth of 10,000 feet. Precautions were taken to restrict pipe movements to a very slow rate while pumping was in progress. It was believed that these measures would govern the pressure surges in the well approximately 100 psi.

The success of the over-all program to keep pressures down was evidenced by the fact that this well was drilled



Test No.	Avg. Time to Spud 35′ of Pipe
1	39½ seconds
2	18 seconds
3	27 seconds
5*	22 seconds

* All surges less than 50 psi

FIGURE 8. Pressure surges due to slowly spudding 35 feet of pipe while circulating.

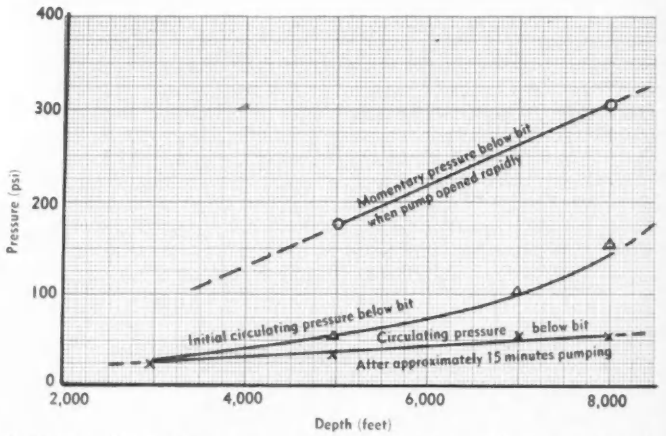
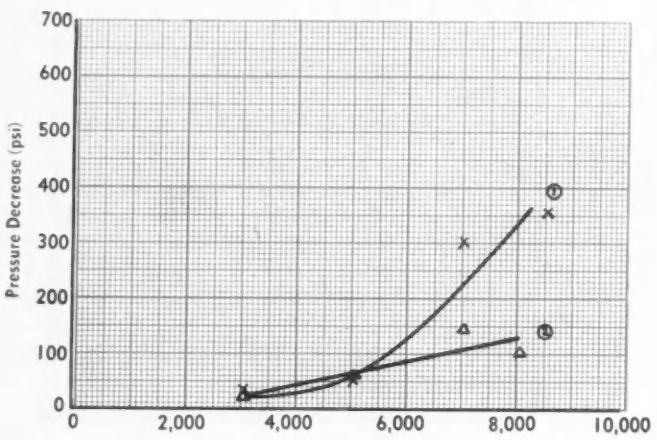


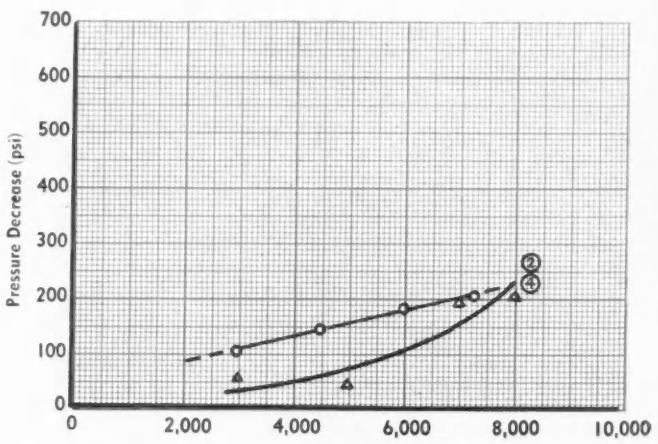
FIGURE 9. Circulating pressures as measured below the bit in Test 2. Surface pump pressure: 1100 psi.



Test No.	Avg. Time to Withdraw One Stand
1	24 seconds
2	33 seconds
4*	27 seconds
5**	36 seconds

* All pressure changes less than 50 psi.
** All pressure changes less than 100 psi.

FIGURE 10. Pressure decrease due to rapidly withdrawing one stand.



Test No.	Avg. Time to Withdraw 35′ of Pipe
1*	25 seconds
2	15 seconds
4	11½ seconds
5*	12½ seconds

* Less than 50 psi pressure reduction at all depths.

FIGURE 11. Pressure decrease due to rapidly withdrawing 35 feet of pipe while circulating.

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to total depth without loss of circulation, even though there had been a total of 79 losses while drilling the three previous wells in this field.

The information on the Peach Point operations has been presented because it shows the circumstances which led to making the tests and is a convincing demonstration of the applicability of the data developed. It is not intended to imply that lost circulation may always be prevented through the methods of keeping pressures in excess of required hydrostatic pressure to a minimum. In some wells exposed formations will not support the necessary hydrostatic pressure; however, it is reasoned that high surge pressures will complicate attempts to seal such formations and might repeatedly break them down, even after they had been sealed sufficiently to support the required hydrostatic pressure.

Figure 12 has been prepared to illustrate the manner in which it is believed that loss of circulation often occurs in abnormal pressure drilling on the Gulf Coast. It is set up for a theoretical hole which would support a mud of 17 ppg density, or a pressure gradient of 0.885 psi per foot without breaking down. This figure approaches the maximum pressure that most holes will withstand. If a 16.0 ppg mud is used, circulation would add a down-the-hole pressure equivalent to about 0.2 ppg mud density increase, and no loss of circulation should occur. If the pipe is spudded rapidly or run in the hole at the usual rates, pressure surges equivalent to about 2.1 or 1.4 ppg of mud density respectively, may result. Either of these, added to hydrostatic and circulating pressures, would exceed the strength of the formation and cause it to take mud.

It is generally recognized from squeeze cementing and acidizing operations that once a formation has been broken down it will take fluid more readily. Once this has occurred the formation may take fluid when circulation is established, or the fluid level may drop, depending upon the strength of the formation after breakdown. It is not implied that in loss of circulation in abnormal pressure wells the formations are always fractured by the pressures in the hole, for it may be true that existing fractures are opened by the pressure.

If a mud of 14.0 density is circulated under the conditions illustrated, then none of the surge pressures would be great enough to break down the formation. If a 16.5 mud is circulated, then opening the pump rapidly would give a surge great enough to break down the formation.

The illustration given is chiefly relative to abnormal pressure drilling where high hydrostatic pressures are required. However, it is believed that the surge pressures will also have an effect on loss of circulation in normal pressure gradient drilling. Since the hydrostatic pressures are not great when this type of loss occurs, it is believed that the formations are not fractured by the well pressures. These losses appear to be due to the drilling of highly porous or cavernous zones through which mud can readily flow. Plugging these zones is difficult, and it is often found that after plugging is accomplished, increasing the mud density slightly will again break the formation down. In such instances it is evident that the plugged hole will support only low pressures. If the surge pressures are added to hydrostatic pressure, values in excess of that which the hole will support may result.

In the drilling of the limestone and dolomite of the Permian Basin losses have frequently been found to occur immediately following a round trip with the bit. This would indicate that surge pressures, due to rapidly running pipe in the hole, may have caused the loss.

Attention should also be given to surge pressures when rapidly running casing. Annular clearances are usually less with casing than with the drill pipe. These surges were not measured but must be of a high order and their effect in causing a loss may easily be imagined.

In summary, whenever the hydrostatic pressure in a well approaches the maximum which the formation will withstand, surge pressures due to pipe movement and rapidly starting pumps may cause loss of circulation. It is believed that they should be avoided in drilling when loss of circulation occurs, or is considered likely. The data developed show that this may be done through governed rates of pipe movement and pump operation.

The information presented herein has only touched upon a subject which needs to be fully developed. Cannon[1] has shown the effect of annular area, gel strengths, and rate of pipe withdrawal on swabbing pressures. Chaney[2] discussed the possibility that "peak pressures caused by a balled bit, rapid lowering of the drill pipe, or by sharp pulsations in pump pressure" may increase pressures above formation strength in abnormal pressure wells. Otherwise, there seems to have been little consideration given to this matter. The effect of both the annular clearance and changes in mud properties on the pressure surges due to pipe movements needs to be clearly shown.

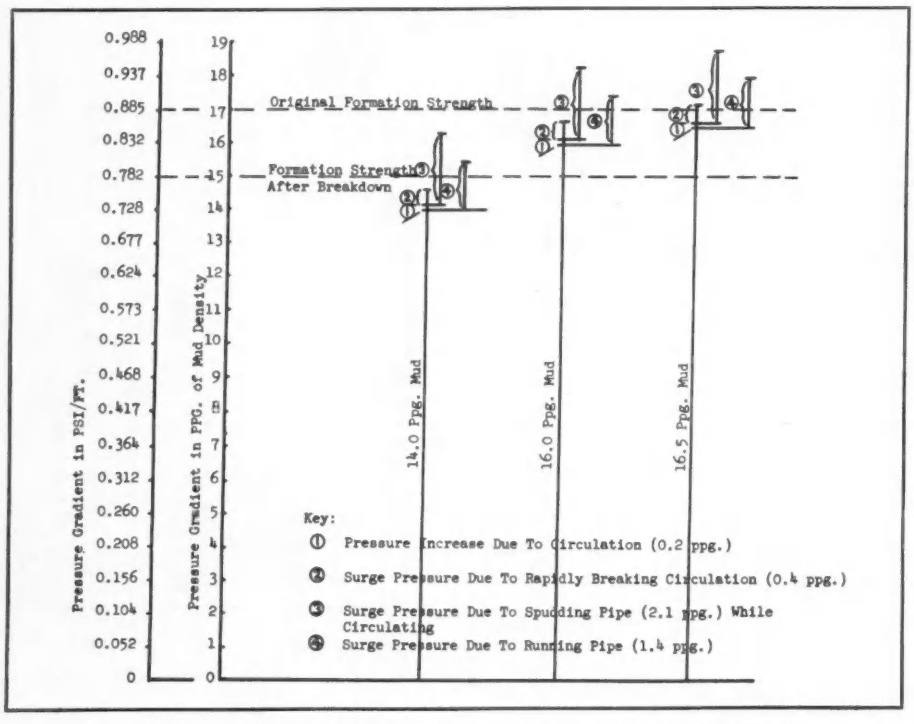
Pressure Gradient in PSI/Ft.
Pressure Gradient in PPG. of Mud Density
Original Formation Strength
Formation Strength After Breakdown
14.0 Ppg. Mud
16.0 Ppg. Mud
16.5 Ppg. Mud
Key:
① Pressure Increase Due To Circulation (0.2 ppg.)
② Surge Pressure Due To Rapidly Breaking Circulation (0.4 ppg.)
③ Surge Pressure Due To Spudding Pipe (2.1 ppg.) While Circulating
④ Surge Pressure Due To Running Pipe (1.4 ppg.)

FIGURE 12. Pressures to cause loss of circulation in a theoretical well.

REFERENCES

[1] George E. Cannon: "Changes in Hydrostatic Pressure Due to Withdrawing Drill pipe from the Hole," *Drilling and Production Practice*, 42-47 (1934).

[2] P. E. Chaney: "Abnormal Pressures and Lost Circulation," *Drilling and Production Practice*, 145-152 (1949).

ACKNOWLEDGMENT

The authors wish to express appreciation to the management of Gulf Oil Corporation, Houston Production Division, and Gulf Research and Development Company for permission to publish this paper.

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Abuses of Wire Ropes

By CHARLES M. ZERR, Chief Engineer
Union Wire Rope Corporation, Kansas City, Mo.

FEW mechanical products are more uniform in tolerance of individual elements and fabricating exactness than wire rope. Yet, largely through lack of knowledge of its structure, considerable footage of rope is injured or ruined by abuses, many of which could be avoided.

Cable tool drilling lines, which normally take about 3 percent of all the wire rope made in the U.S., suffer the majority of abuses.

Heaviest wear on the rotary tool drilling rope occurs when the drill pipe must be removed from the hole to replace the bit. This necessitates raising the entire string of pipe and calls for an enormous amount of work by the rope, the measurement of this work being expressed as ton-miles. The rope in a given field is usually required to yield a given ton-mile service, although this service may vary for the same rope in different fields.

The greatest wire rope abuse is in drum crushing, grinding or in fatigue developed in the sheaves of the blocks. A more complete understanding of the main causes of premature wire rope failure is important in attaining a higher degree of safety and economy.

Figure 1 illustrates three stages in the life of wire rope and the various types of abuse to which it is subject. These stages are as follows:

- Handling and shipping.
- Installation.
- Rig use.

When a rope is kinked or sharply bent, it acquires a permanent bend, or set, which is very harmful to rope life. Dog legs, as these permanent bends are called, are common to almost every kind of field service and may result from several possible abuses:

- Kinking the rope and pulling out the loops.
- Improper winding on the drum.
- Pulling rope around a post, sill or other sharp object.

Dog legs are frequently caused by open-drum reels having spokes too widely spaced. Pressure from the outer layers of rope fixes permanent bends on the inner layers where the rope passes over the spokes. Kinks, if severe, will cause destructive displacement of the strands; these kinks can be such as to open up or loosen the strands, or to tighten or close the strands.

Another major source of rope abuse during installation is the method of attaching the end fittings. This is particularly true of socketing, which frequently causes high or drawn strands. High strands cause early rope failure due to the loosening of one or more of the strands to a position farther from the axis of the rope, giving such strands most of the surface wear.

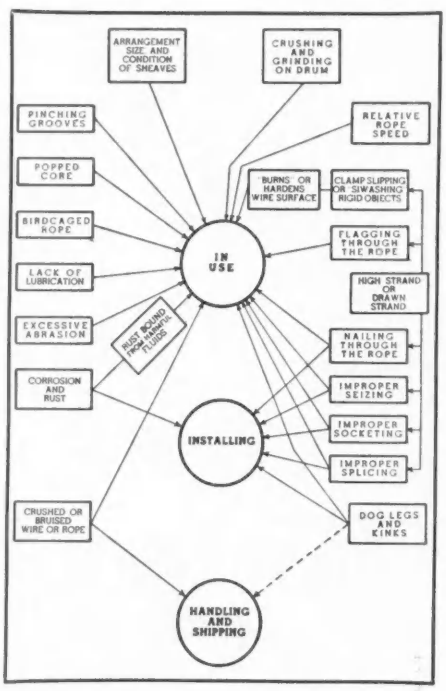


FIGURE 1. Classification of rope abuse types.

Loosening strands in any part of the rope can cause high strands. Nailing through the rope is destructive to its life and may start a high strand. Putting a flag through the rope as a marker damages the rope and may cause high strands.

Improper or insufficient tying or seizing of the rope is frequently responsible for numerous cases of high stranding ropes. There are two approved methods of seizing ropes. The important feature is to have at least four seizings on each side of the cut for wire-centered ropes, and at least three seizings on each side for all other ropes that are not preformed. Clamp slipping may high strand the rope, causing burns and shortening its life.

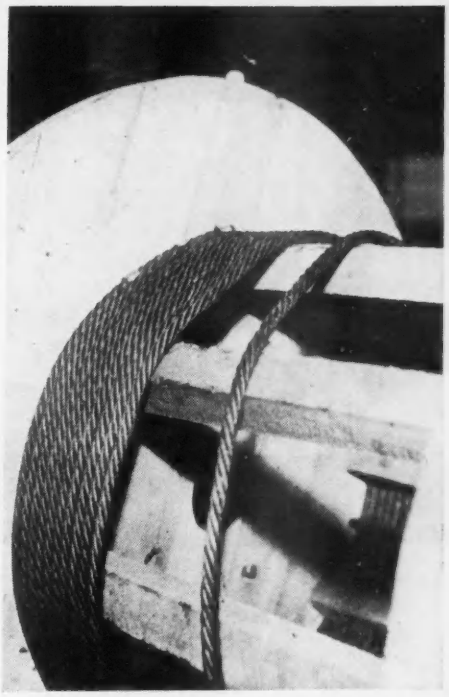
As a rope is used, it stretches and is worn, both of which reduce its diameter. The used, smaller rope wears the grooves of the sheaves and drums, so that after considerable service, the grooves become smaller than the new oversized rope. This causes a pinching of the new rope, which greatly reduces its service expectancy. A worn or corrugated sheave is also detrimental to rope life. The only solution to such wear is to enlarge the tread diameter or to increase the hardness of the material of which the sheave is made. Frequently, it is necessary to do both.

The list of wire rope abuses would not be complete without mentioning proper lubrication. Rust eats away the material in the rope, pits the surface and greatly reduces the physical properties of the wire. Rust causes a hide-bound rope, frequently resulting in a one-stand break because the rope has become inelastic. Rust also cuts and chafes the fiber core causing its deterioration.

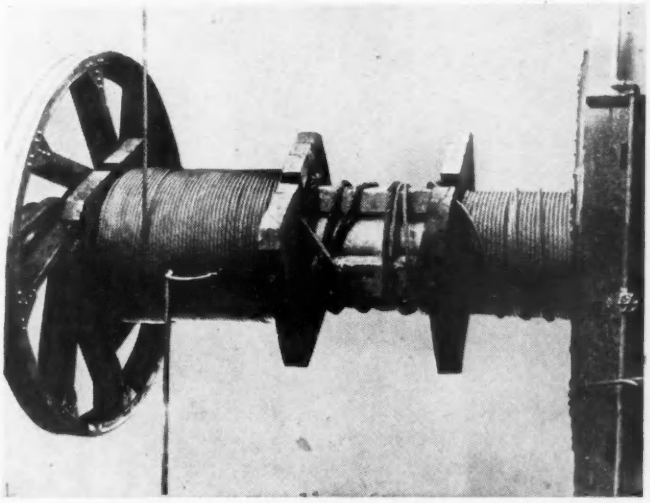
These are but a few of the major forms or rope abuse but they are sufficient to show the need for a closer study of wire rope failures so as to place the responsibility and to attempt more efficient care.

A dog leg just made; wires not yet worn.

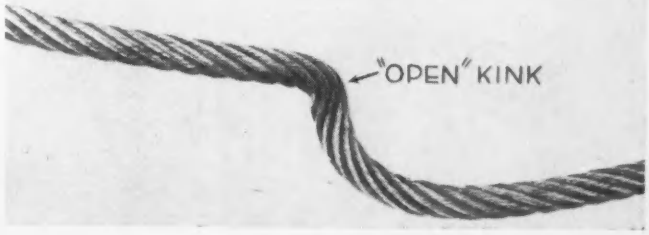
Broken ends as result of wires worn to a knife-edge from a dog leg.



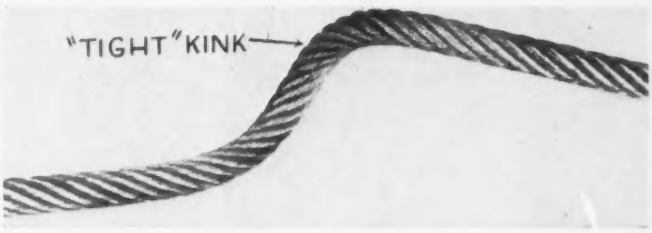
Dog-legs frequently are caused by open-drum reels having spokes too widely spaced.



Poor lagging between divers dog-legs the line.

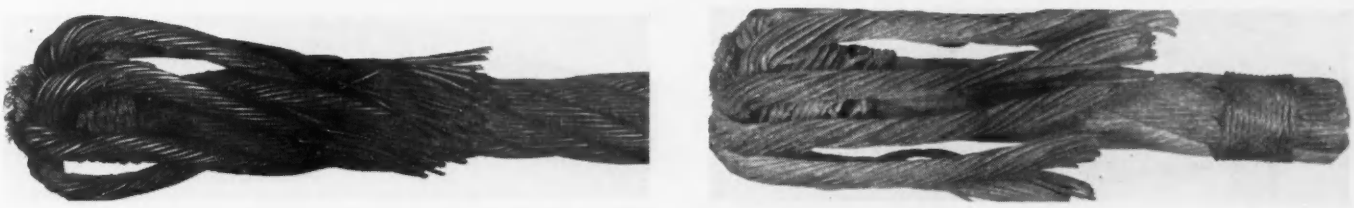


Open kink opens the lay.



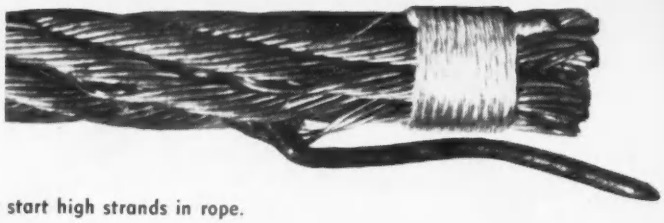
Tight kink shortens lay.

Three ropes abused by "open" kinks.

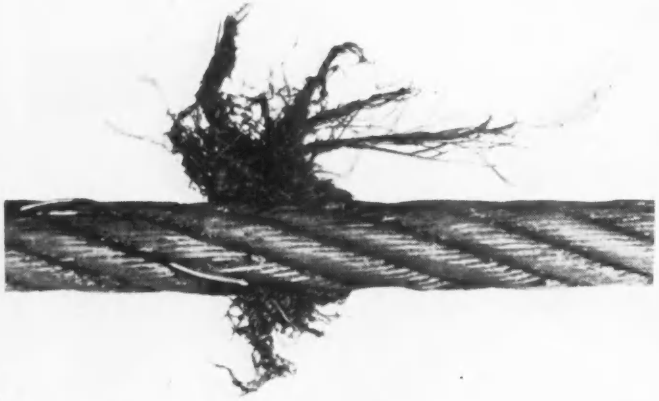


Two "dry" socket ends. These socket end preparations may cause a high-stranded line.

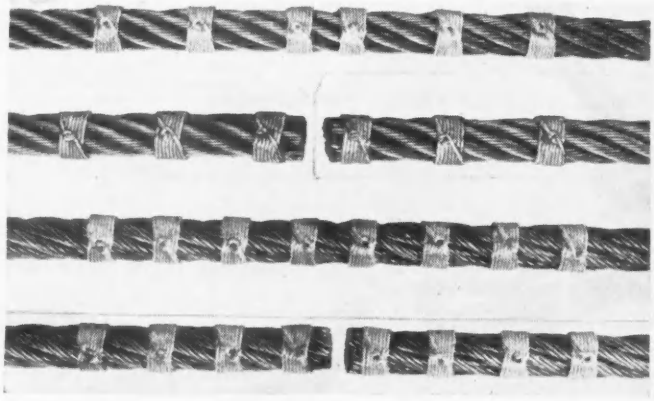
See photos on next page →



Ropes damaged by spiking may start high strands in rope.



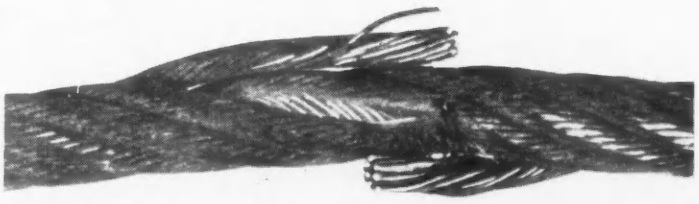
Putting a "flag" through rope as a marker damages rope and may cause high strands.



Examples of correct seizing, before and after cutting.

Abuse by clamp slipping. Left, slipping line through the clamp. Center and right, slipping line through clamp "burns" wire and shortens service.

Rope abuse caused by excessive bending and pinching in worn sheave grooves.



LEFT: Worn sheave is destructive to wire rope. Tread diameter too small and material too soft for the duty results in first pinching rope, then heavy abrasion. Note corrugation of groove from excessive rope pressure. Upper flange has been worn off by rope.

RIGHT: One-strand break from rust-bound condition.

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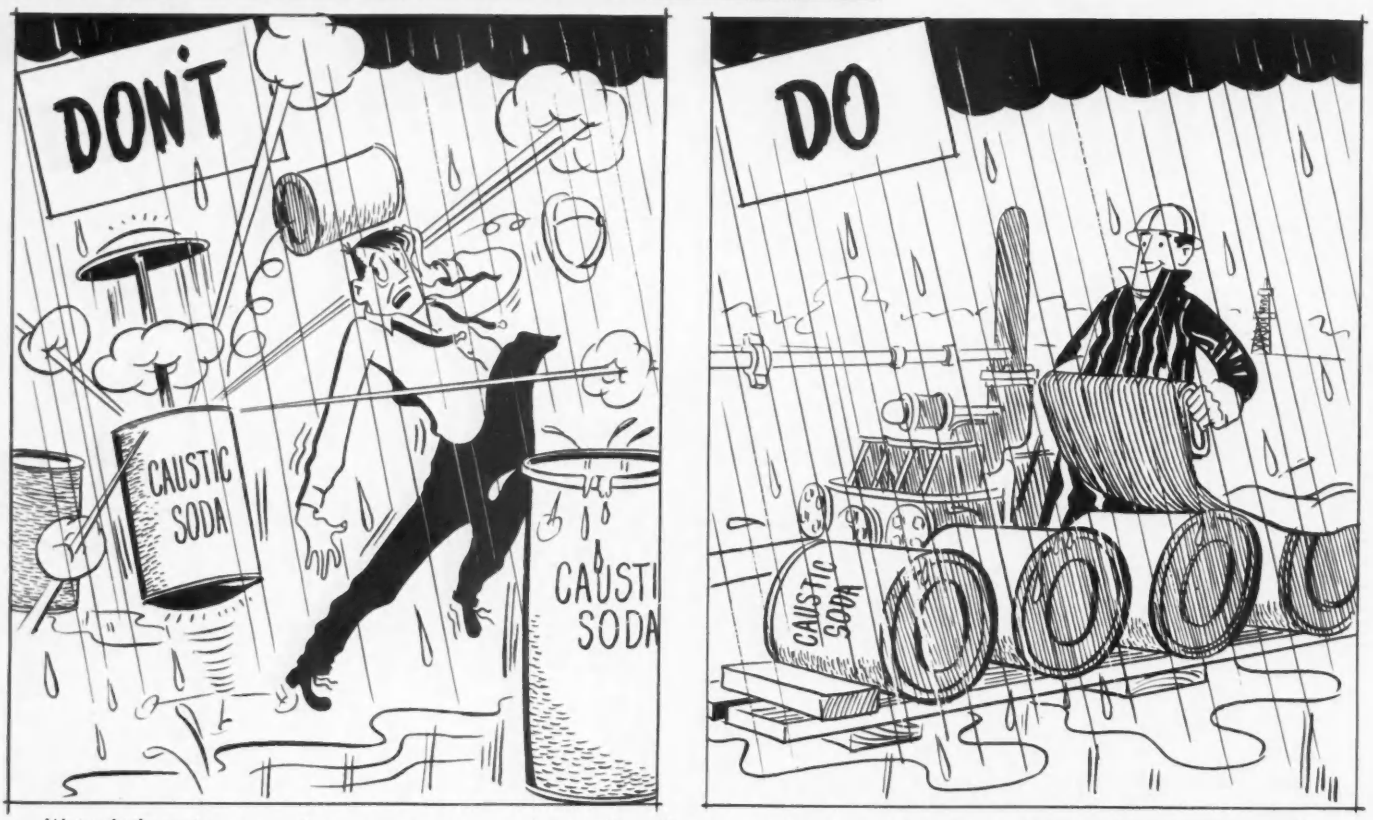


Water leakage into a caustic can may cause an explosion. When the cans are stored on their sides, the indented lids will not trap water.

Wet quebracho will harden and become impossible to use. If stored in a dry place, the material will be powdery when needed.

Unitized *Flow Line* Aids Rigging-Up And Handling of Drilling Fluid

By W. B. COLVIN, WORLD OIL Staff

TWO flow lines equipped with underslung sand traps are among the major features on a unique system installed by Magnolia Petroleum Company on Rig 32, operating in the Hockley, Texas, field.

The design offers ease of transportation and diversion of the mud stream to permit more efficient conditioning of the drilling fluid and sand traps, which may be cleaned without interrupting the mud flow. Further, it is possible to handle conveniently flocculated mud resulting from lime conversions or the invasion of contaminating agents.

The basic design of the unit resulted from the presence of mud-damaging minerals and formations peculiar to the Hockley structure. The process of completing an operation in the area often involves the penetration of readily dispersible shales, gyp and rock salt. The introduction of these constituents often requires the immediate and radical treatment of the drilling fluid. However, with the dual flow line available, it is possible to reduce the flow volume and velocity of the mud stream and introduce concentrated chemical into the system. Thus, the prevailing mud ailment may be more rapidly overcome.

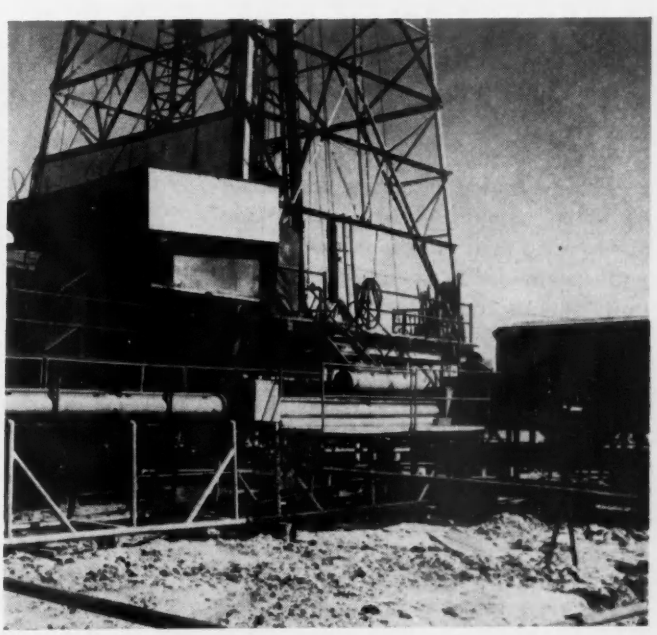
HERE IS a time-saving device in the form of a unitized flow line unit. The equipment is fabricated in a manner to provide dual flow lines to assist in the effective conditioning of drilling fluid, permit cleaning sand traps without the interruption of circulation, and provide additional facilities for handling flocculated mud. Complete portability is afforded through the breaking of flanged couplings which permits moving the unit as two independent sections. After the units have been spotted on location, it is possible for one man to complete the rigup job quickly.

The flow line traps collect sand and other large, high specific gravity particles to prevent their entrance into the shale pit. By keeping the shale pit free of foreign matter, it is always possible to maintain a greater volume in the mud system to combat the occurrence of lost circulation.

A hinged walkway extends along the rig side of the unit. A partial walkway has been provided on the other side to permit ready access to the dual chemical treating tanks. The walkways, being floored with non-skid expanded metal, are designed with one-inch folding guard rails to insure maximum safety for crew members.

The 28-inch chemical treating

Hinged covers are on the flow lines to permit more convenient cleaning of the sand traps. Trapped residue within these scavenger chambers is removed through clamp type doors cut in the base of the sand traps. The 28-inch treating tank has been partitioned to permit the blending and addition of two different chemical solutions into the mud system. Expanded metal walk-ways, equipped with one-inch guard rails, allows easy access to the flow lines and treating tank.



An over-all view of the Magnolia dual flow line system. The 20-inch flow line to the shale pit is cradled in a three-inch pipe base and may be transported as an independent unit. Steel header boxes channel mud from the shaker through the dual flow line system and finally into the single line leading to the shale pit. Treating chemicals for the mud are available from the 28-inch tank above the twin flow lines.

tanks are designed as dual containers to permit the blending of two different solutions for introduction into the mud system. Hinged lids are provided to eliminate the possibility of foreign matter entering the chemical solution. Water is piped into each compartment to expedite the process of blending chemicals.

Steel gathering boxes are installed adjacent to the shale shaker and the single line leading to the shale pit. The box gathering mud from the shale shaker is equipped with plate steel gates to allow the channeling of drilling fluid through one line independently, or both lines simultaneously.

Flange Arrangement

The unit is flanged where the single line, leading to the shale pit, junctions with the gathering box. In this manner, it is possible to prepare the systm for transport as two independent units. Additional flanges are stationed at the edge of the shale pit and on a nipple extending from the shale shaker. The flow line section at the shale pit also serves as a by-pass system since a slide-type gate has been installed to divert mud to the settling pit or second tank. Installation of the unit on location simply involves the initial alignment of the two parts, bolting the three flanges, erecting the permanently attached folding walkways, and connecting the water line to the chemical tanks. This simple method of installation, after the units have been properly spotted on location, may easily be carried out by one man.

The supporting members of this unit are fabricated of three-inch pipe with plate cradle supports for the 20-inch flow line connecting the shale pit. The rugged base skids are made of 4½-inch drill pipe to insure proper and permanent alignment of the unit, plus increased ease of handling.

The dual flow line section is constructed of 13⅜-inch slotted casing to provide for the underslung sand traps. Access to the traps is through clamp-type sealed ports in the base of the unit. By blocking off one of the flow lines and removing the trap lock plate, it is possible to wash residue from the trap in minimum time.

The initial expense involved in the construction of this welded unit exceeds the cost of the wooden type ditch; however, the speed with which the unit may be placed in service is conducive to a more rapid assembly of the entire rig.

Reclaimable Cement Insulates Boilers

NOT too many years ago, the boilers that fed steam to drilling rigs were bare of insulation. Heat (and fuel) were dissipated in the surrounding atmosphere in profligate fashion. The bare boilers were a common sight, typical of the speculative, rough-and-ready industry that existed then.

But the engineers had their excuses, at that. Their boilers were exposed to weather, because they weren't spotted in any one location long enough to justify housing them. Fuel was cheap, and moves were frequent—moves that saw the boilers banged and bumped, roughly skidded on and off trucks. Under those circumstances, they reasoned, what manner of insulation would stand up anyway?

Today, however, more and more oil field boilers are holding their steam longer and using less fuel because they bear thick coats of insulation—almost exclusively of the cement variety—in spite of the rough treatment. In this material, crews have found insulation which can be repaired quickly, easily and on the job, no matter how severe the abuse.

Basically, the cement is mineral wool in nodule form, each resilient pellet containing countless minute air cells. With fiber and binders added, it is shipped dry, then mixed with water on the job to form a highly adhesive cement.

Applied and allowed to dry, it becomes a one-piece monolithic coating, free from seams or joints and effective up to 1800° F. Mineral wool insulating cements are made to the following requirements: volumetric shrinkage on drying, which occurs principally in thickness, 20 percent maximum; and dry coverage per 100 pounds of cement, minimum of 45 square feet, one inch thick; adhesion to steel surfaces after drying, minimum, three pounds per square inch. Also, its close adhesion to the heated surface means a total absence of flue effects, with their resultant losses by convection, which might develop with ill-fitting insulation.

Government specifications require that the thermal conductivity of these cements shall not exceed 0.70 British thermal units at 200° F. mean temperature, 1.80 Btu at 400° F. Actually, the mineral wool cements of typical manufacturers exhibit thermal performance considerably superior to these values.

An economy quality unique with this material is its reclaimability, which saves money on both labor and material. When repairs or inspection are required on pipe fittings or handhole plates, for example, the cement may be removed, remixed with water and used again. Complete reclaimability extends to temperatures to 1000° F.

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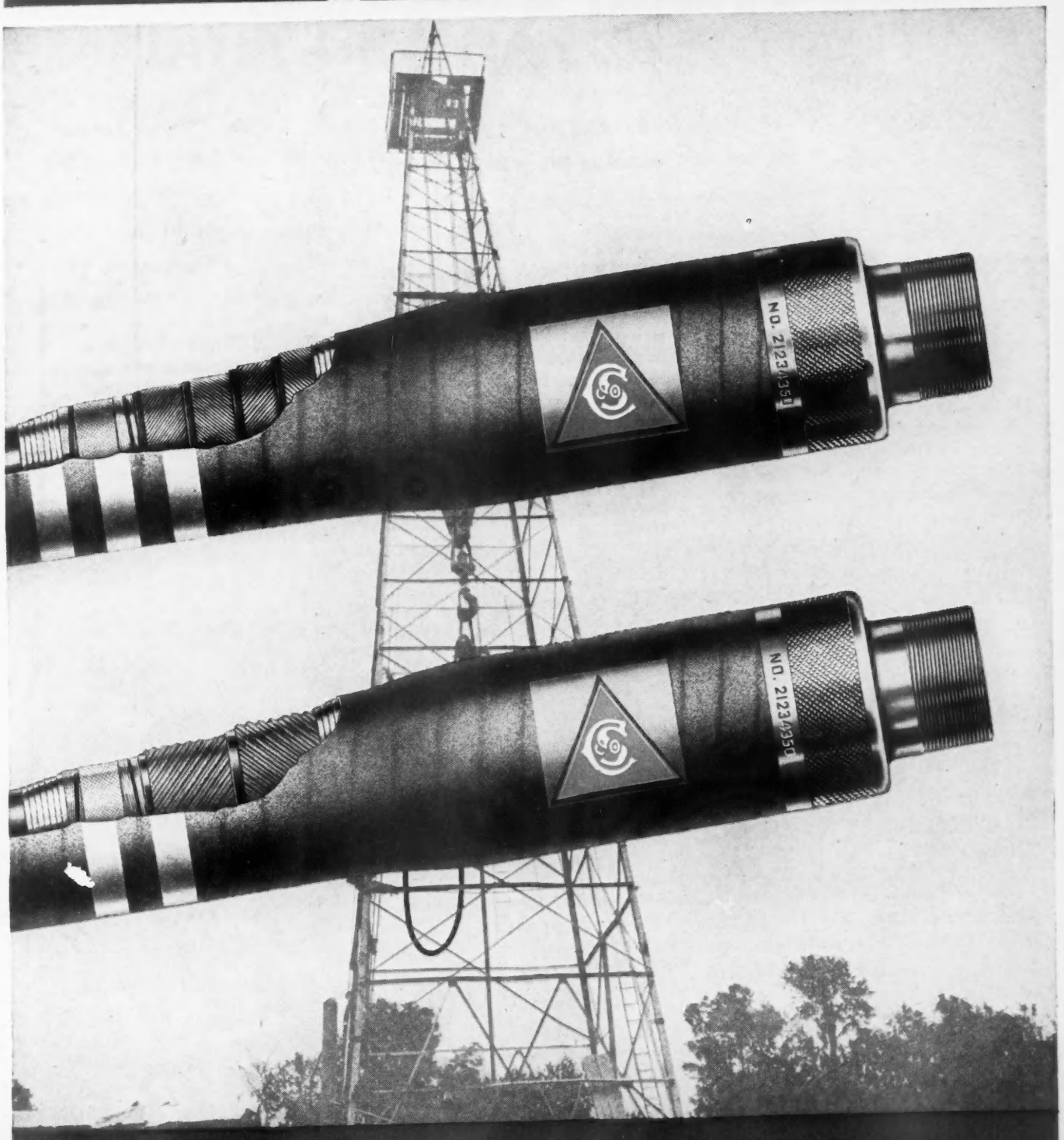

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BUCKLING
Of Rotary Drilling Strings

Part 4 (Conclusion)

By ARTHUR LUBINSKI
Stanolind Oil & Gas Company

CONCLUDING THE mathematical analysis of forces leading to buckling of the drilling string, the author presents mathematical equivalents for the various theoretical considerations developed in Parts 1 and 2 of this series. As a further development he also evaluates the effect of combination drilling strings and the effect of hydrostatic pressures on the string.

THE length L of a curve between two points of abscissas equal to X_1 and X_2 is equal to

$$L = \int_{X_1}^{X_2} \sqrt{1 + \left(\frac{dy}{dx}\right)^2}\, dX$$

In the case of drilling strings, Y is small with regard to X and therefore after expanding the square root in series, all the terms but the first two may be neglected. Thus we obtain:

$$\Delta L = (X_2 - X_1) + \frac{1}{2}\int_{X_1}^{X_2} \left(\frac{dy}{dx}\right)^2 dX$$

As $X_2 - X_1$ is the length of the projection of the drilling string on the axis of the hole, the increase ΔL of the length of this projection, which is due to buckling, is equal to

$$\Delta L = \frac{1}{2}\int_{X_1}^{X_2} \left(\frac{dy}{dx}\right)^2 dX \quad \ldots\ldots (66)$$

Substituting (21) and (22) into (66), we obtain

$$\Delta L = \frac{r^2}{2m}\int_{X_1}^{X_2} \left(\frac{dy}{dx}\frac{m}{r}\right)^2 dX \quad \ldots\ldots (67)$$

Substituting (60), (61) and (62) into the equation (37), we obtain the values of $\frac{dy}{dx}\frac{m}{r}$ for the buckling of the first order.

Substituting (63), (64) and (65) in the equation (37), we obtain the values of $\frac{dy}{dx}\frac{m}{r}$ for the buckling of the second order. The curves $\left(\frac{dy}{dx}\frac{m}{r}\right)^2$ versus x were plotted and integrated with a planimeter from $x_1 = -4$ to $x_2 = 2.04$ and from $x_1 = -4$ to $x_2 = 4.05$ for the buckling of the first and second order respectively. Substituting the obtained values in the expression (67), the expressions (12) and (13) used in Part one were found.

FORMULATION OF PROBLEM. From the equation (55), we have deducted that a buckled form of the first order is stable only for one value of the weight on bit, i.e., value corresponding to $x_2 = 2.04$. The buckled form of the second order is stable only for $x_2 = 4.05$. It shall be investigated now what happens after the buckling of the first order occurred and the weight of bit is gradually increased to the values of x_2 between 2.04 and 4.05. Apparently there should be no buckling at all. Such a conclusion is erroneous, because the differential equation (20) which was the starting point for all our deductions does not hold true any more for the whole length of the drilling string. For the upper portion of the drilling string, that is to say for the part located above the point of tangency (see Figure 19), we must take into consideration the force F which is the reaction of the wall of the hole against the pipe. The equation (20) is replaced by

$$EI\frac{d^3Y}{dX^3} + pX\frac{dY}{dX} + F_2 - F = 0 \quad (68)$$

The expression (28) and the differential equation (32) are replaced by

$$c_1 = \frac{F_2 - F}{pm} \quad \ldots\ldots (69)$$

and

$$\frac{d^2z}{dx^2} + xz + c_1 = 0 \quad \ldots\ldots (70)$$

respectively.

The integration of the differential equations (32) and (70) gives the same kind of general solution, viz. (36), (37) and (38). However, not only c, but also the integration constants a, b and f become different for the lower and upper portions of the drilling string.

Constants corresponding respectively to the upper and lower portions of the drilling string will be designated by subscripts 1 and 2 respectively. Then the equations corresponding to the upper portion are:

$$y = a_1S(x) + b_1T(x) + c_1U(x) + f_1 \quad \ldots\ldots (71)$$

$$\frac{dy}{dx} = a_1F(x) + b_1G(x) + c_1H(x) \quad \ldots\ldots (72)$$

$$\frac{d^2y}{dx^2} = a_1P(x) + b_1Q(x) + c_1R(x) \quad \ldots\ldots (73)$$

and those corresponding to the lower portion are:

$$y = a_2S(x) + b_2T(x) + c_2U(x) + f_2 \quad \ldots\ldots (74)$$

$$\frac{dy}{dy} = a_2F(x) + b_2G(x) + c_2H(x) \quad \ldots\ldots (75)$$

$$\frac{d^2y}{dx^2} = a_2P(x) + b_2Q(x) + c_2R(x) \quad \ldots\ldots (76)$$

$$c_2 = \frac{F_2}{pm} \quad \ldots\ldots (77)$$

LOCATION OF POINT OF TANGENCY. Let x_1 correspond, as previously, to the upper end of the drilling string, or rather to the point where $x_1 = -4$. Let x_2 correspond to the lower end of the drilling string, and x_3 to the point at which the pipe is tangent to the wall of the hole. The three boundary conditions for the upper portion of the drilling string are as follows:

1. The bending moment is equal to zero at the upper end of the drilling

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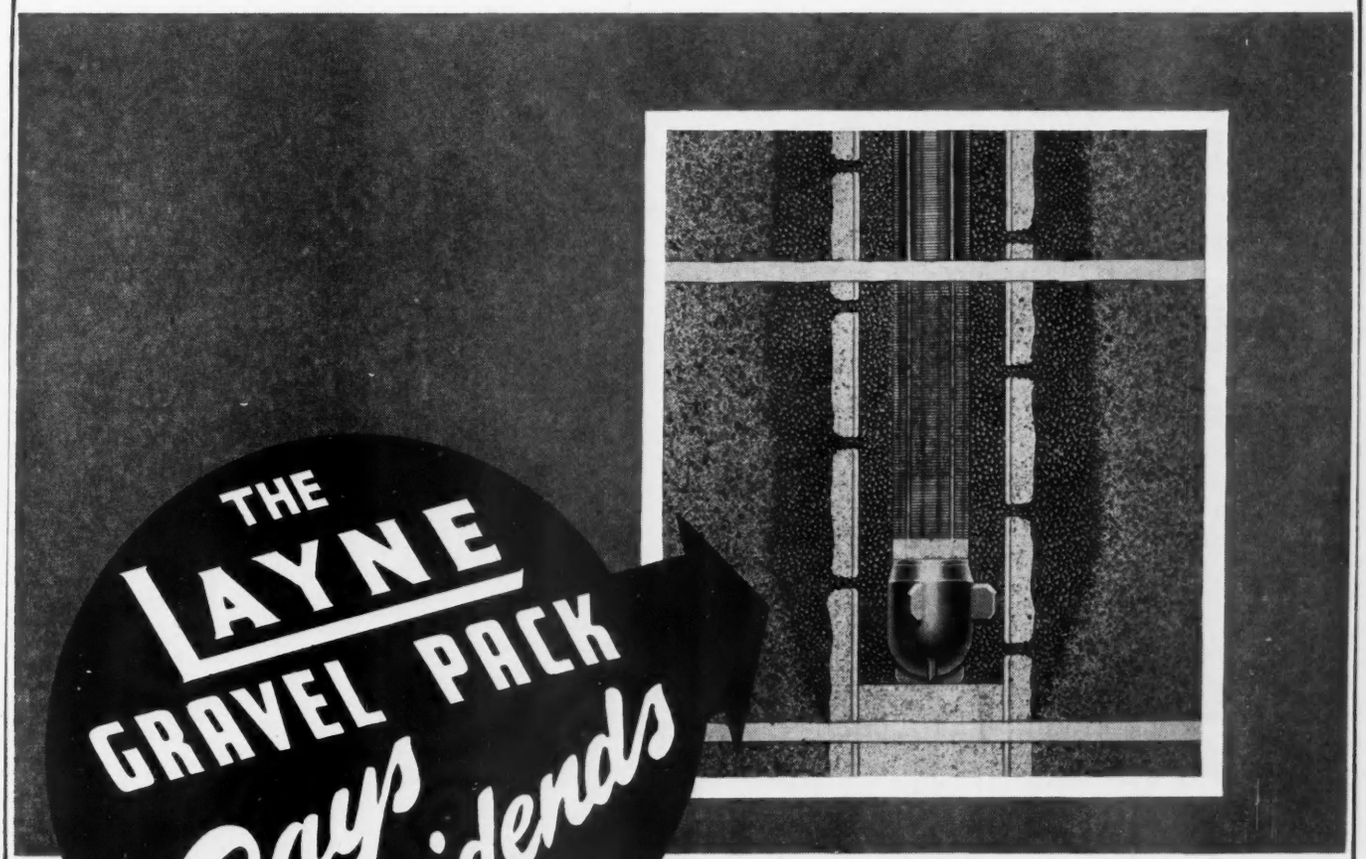

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string, which leads to equation (78)

2. $\frac{dy}{dx}$ is equal to zero for $x = x_3$ which leads to equation (79).

3. For $x = x_1$, $y = 0$

4. For $x = x_3$, $y = \frac{r}{m}$

These last two conditions when introduced into the equation (71) give two expressions from which f has been eliminated, giving finally the equation (80).

Consequently, the set of equations corresponding to the upper part of the drilling string is:

$$\begin{cases} a_1P_1 + b_1Q_1 + c_1R_1 = 0 \quad \ldots\ldots(78) \\ a_1F_3 + b_1G_3 + c_1H_3 = 0 \quad \ldots\ldots(79) \\ a_1(S_3 - S_1) + b_1(T_3 - T_1) + c_1(U_3 - U_1) = \frac{r}{m} \quad \ldots\ldots(80) \end{cases}$$

In these equations x_1 is equal to -4. By varying x_3, we find for each value of x_3 a set of values for $\frac{a_1}{\left(\frac{r}{m}\right)}$, $\frac{b_1}{\left(\frac{r}{m}\right)}$, and $\frac{c_1}{\left(\frac{r}{m}\right)}$ and by substituting into equation (73), we find the corresponding values of $\frac{d^2y}{dx^2}$. These last values, designated as B, will be used in the lower portion of the drilling string, because for $x = x_3$ the values of $\frac{d^2y}{dx^2}$ are the same for both portions of the string. This is because the bending moment does not change in a discontinuous manner when passing by the point 3. The shearing force and therefore $\frac{d^3y}{dx^3}$ change discontinuously, but $\frac{d^2y}{dx^2}$, $\frac{dy}{dx}$ and y are continuous at the point 3.

The boundary conditions are the same for the lower portion of the drilling string as they were for the upper part: therefore, no explanation is needed for the equations (81), (82) and (83) below, which are analogous to the equations (78), (79) and (80). Furthermore, the equation (84) expresses the fact that $\frac{d^2y}{dx^2}$ is equal to B, as stated above.

Consequently, the equations of the lower portion of the drilling string are

$$\begin{cases} a_2P_2 + b_2Q_2 + c_2R_2 = 0 \quad \ldots\ldots(81) \\ a_2F_3 + b_2G_3 + c_2H_3 = 0 \quad \ldots\ldots(82) \\ a_2(S_3 - S_2) + b_2(T_3 - T_2) + c_2(U_3 - U_2) = \frac{r}{m} \quad \ldots\ldots(83) \\ a_2P_3 + b_2Q_3 + c_2R_3 = B \quad \ldots\ldots(84) \end{cases}$$

This set of four equations containing three unknowns a_2, b_2 and c_2 requires as condition for having a possible solution the following relation:

$$\begin{vmatrix} P_2 & Q_2 & R_2 & O \\ F_3 & G_3 & H_3 & O \\ S_3 - S_2 & T_3 - T_2 & U_3 - U_2 & -\frac{r}{m} \\ P_3 & Q_3 & R_3 & -B \end{vmatrix} = 0 \quad \ldots\ldots(85)$$

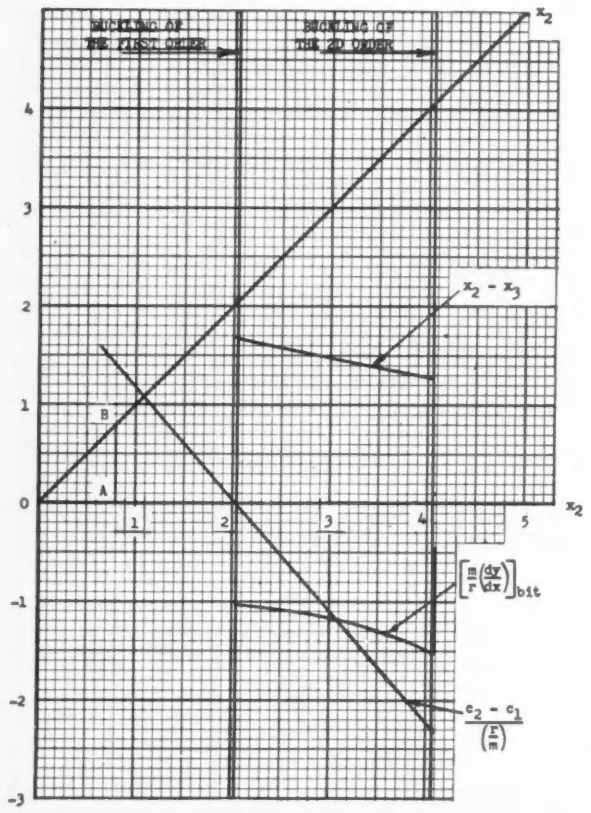

FIGURE 30

(All units are dimensionless)

The above equation is the relation between x_3 and x_2. The values of x_2 corresponding to various values of x_3 were determined by trial and error. The corresponding values of $x_2 - x_3$ were plotted on Figure 30 as function of x_2. As pointed out previously, x_2 represents the weight on bit and $x_2 - x_3$ is the distance from the bit to the point where the pipe is tangent to the wall of the hole. Figure 30 shows that this distance decreases slightly when the weight on bit increases.

It may often be desirable to determine the relative position of the point of tangency with respect to the neutral point. For this purpose Figure 30 shows a line OB inclined at 45° with respect to coordinate axes. For any point of this line such as B, the abscissa OA represents the weight on bit and the corresponding ordinate AB represents the distance from the bit to the neutral point. The analysis of the location of the point of tangency was made in the first part of this article.

SHAPE OF BUCKLED CURVES. The shape of curves representing the axes of the buckled drilling string for the weight on bit between the critical values of the first and second order shall now be determined. In this connection it should be pointed out that the coefficients $\frac{a_1}{\left(\frac{r}{m}\right)}$, $\frac{b_1}{\left(\frac{r}{m}\right)}$, and $\frac{c_1}{\left(\frac{r}{m}\right)}$ corresponding to the upper portion of the pipe have been calculated. We must now determine the corresponding coefficients for the lower part of the drilling string. This can be done by choosing any three out of the four equations (81), (82), (83) and (84) and solving such a system. Thus the values of $\frac{a_2}{\left(\frac{r}{m}\right)}$, $\frac{b_2}{\left(\frac{r}{m}\right)}$, $\frac{c_2}{\left(\frac{r}{m}\right)}$ were determined for each set of values of x_2 and x_3.

The shapes of some buckled curves were determined by substituting $\frac{a_1}{\left(\frac{r}{m}\right)}$, $\frac{b_1}{\left(\frac{r}{m}\right)}$, $\frac{c_1}{\left(\frac{r}{m}\right)}$ and $\frac{a_2}{\left(\frac{r}{m}\right)}$, $\frac{b_2}{\left(\frac{r}{m}\right)}$, $\frac{c_2}{\left(\frac{r}{m}\right)}$ into equations (71) and (74) respectively. The curves 2 and 3 of Figure 10 correspond to $x_2 = 3.2$ and $x_2 = 4$ respectively.

FORCE ON WALL OF HOLE. We shall determine now the reaction F of the wall of the hole on the buckled pipe (see Figure 19). Subtracting the expressions (77) and (69), we obtain

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$$\frac{F}{pm} = c_2 - c_1 \quad \ldots\ldots\ldots\ldots (86)$$

Since the values of $\frac{c_2}{\left(\frac{r}{m}\right)}$ and $\frac{c_1}{\left(\frac{r}{m}\right)}$ were determined, their difference is equal to

$$\frac{c_2 - c_1}{\left(\frac{r}{m}\right)} = \frac{F}{pr} \quad \ldots\ldots\ldots (87)$$

and is proportional to F. The value of $\frac{c_2 - c_1}{\left(\frac{r}{m}\right)}$ was plotted on Figure 30 against x_2. By inspecting this figure we may see that for the weight on bit smaller than the critical value ($x_2 = 2.04$), $\frac{c_2 - c_1}{\left(\frac{r}{m}\right)}$ is positive which means that the pipe should be pulled toward the wall in order to be bent. For the critical value ($x_2 = 2.04$) the pipe buckles, but it contacts the wall with a force equal to zero at the point of contact.

As the weight on bit becomes larger the critical weight, the value of $\frac{c_2 - c_1}{\left(\frac{r}{m}\right)}$ increases rapidly. Immediately prior to the buckling of the second order, this value is equal to 2.3, which explains the expression (3) used in the first part of this article.

INCLINATION OF STRING AT BIT. The tangent of the angle between the buckled pipe and the vertical is equal to $\frac{dY}{dX}$ or to $\frac{dy}{dx}$ (see expression 23). In order to determine the value of $\frac{dy}{dx}$ at the bit, one can substitute into the equation (37) the values $\frac{a}{\left(\frac{r}{m}\right)}$, $\frac{b}{\left(\frac{r}{m}\right)}$ and $\frac{c}{\left(\frac{r}{m}\right)}$ corresponding to the critical weight on bit of the first order ($x_2 = 2.04$) and the second order ($x_2 = 4.05$). Similar substitutions of $\frac{a_2}{\left(\frac{r}{m}\right)}$, $\frac{b_2}{\left(\frac{r}{m}\right)}$ and $\frac{c_2}{\left(\frac{r}{m}\right)}$ into equation (75) for the weights on bit between the two critical conditions lead to corresponding values of $\frac{dy}{dx}$. The curve of $\left[\frac{m}{r}\left(\frac{dy}{dx}\right)\right]_{bit}$ vs. x_2 i.e. the weight on bit, has been plotted on Figure 30. $\left[\frac{m}{r}\left(\frac{dy}{dx}\right)\right]_{bit}$ is equal to 1.02, 1.50 and 0.44 for the buckling of the first order, immediately prior to the buckling of the second order and for the buckling of the second order respectively, which explains the expressions (9), (10) and (11) used in the first part of this paper.

For a combination string comprising drill pipe and drill collars, two different cases must be considered according to the location of the neutral point, which may be in the drill pipe or in the drill collars.

Let W_1 designate the critical weight of the 1st order
Let W_2 designate the critical weight of the 2nd order
Let L_c designate the total length of drill collars in feet
Let m_c designate the length in feet of one dimensionless unit of collars
Let m_p designate the length in feet of one dimensionless unit of pipe
Let p_c designate the weight per foot of the drill collars in lb/ft.
Let p_p designate the weight per foot of the drill pipe in lb/ft.

FIRST CASE. The neutral point is located in the drill pipe. The critical weight on bit is equal to the weight of drill collars plus the weight of a portion of drill pipe. The collars' length in dimensionless units is $\frac{L_c}{m_c}$. Therefore, for critical conditions of the first order, the length of the portion of the drill pipe located below the neutral point is equal to (in dimensionless units) $2.04 - \frac{L_c}{m_c}$. The weights of these two portions of the drilling strings are $L_c p_c$ and $\left(2.04 - \frac{L_c}{m_c}\right) m_p p_p$ respectively. Their sum is equal to:

$$W_1 = L_c\left[p_c - \frac{m_p}{m_c}\, p_p\right] + 2.04\, m_p p_p \quad \ldots\ldots\ldots\ldots (88)$$

The analogous expression for the critical conditions of the second order is

$$W_2 = L_c\left[p_c - \frac{m_p}{m_c}\, p_p\right] + 4.05 m_p p_p \quad \ldots\ldots\ldots\ldots (89)$$

Consequently, the critical weights are linear functions of the total length of drill collars. The above expressions

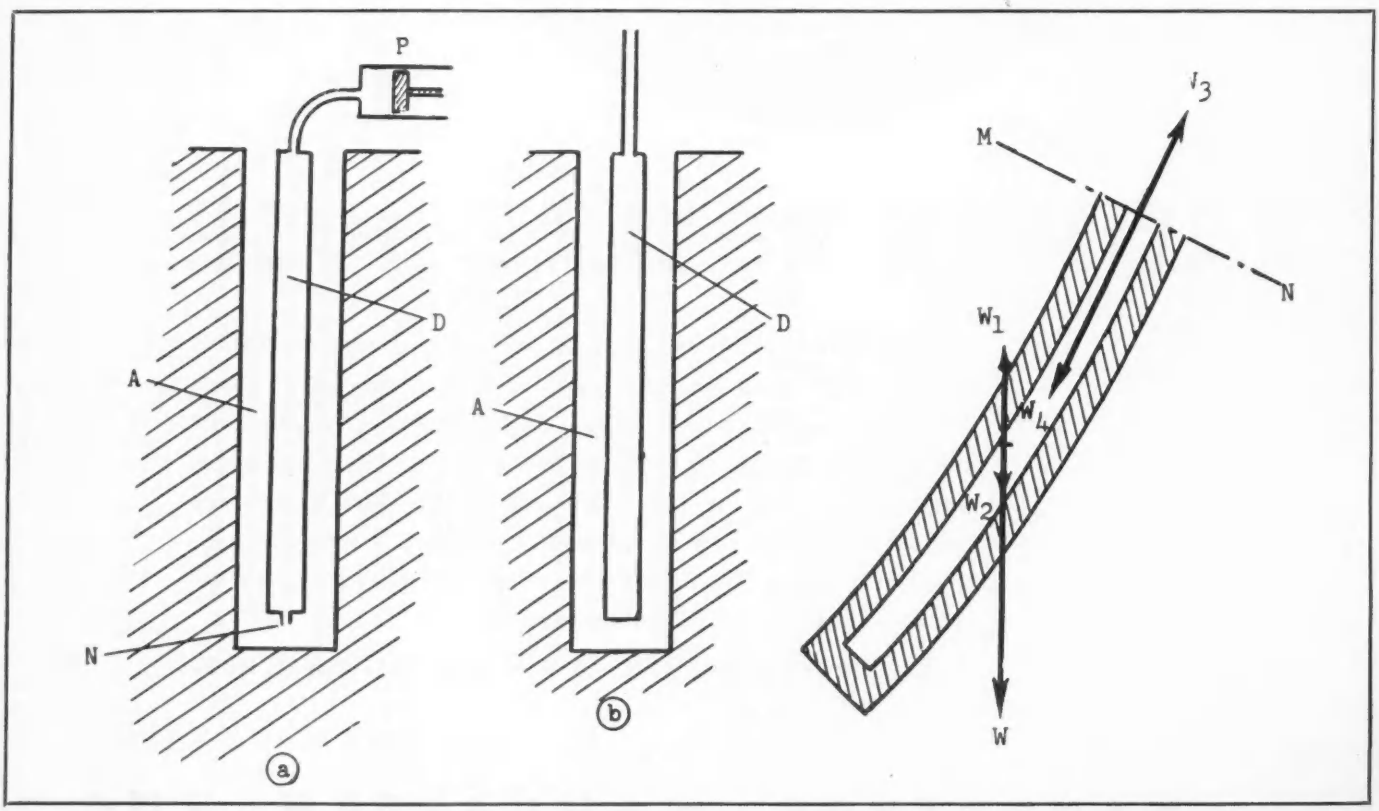

FIGURE 31 Influence of drilling string pressure drop on buckling.

FIGURE 32

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of W_1 and W_2 were applied to three different combinations of drill pipe and drill collars and the result plotted on Figures 4, 5 and 6, (inclined portions of the diagrams).

SECOND CASE. The neutral point is located in the drill collars.

The whole weight on bit is given by the drill collars. The critical values of weight on bit cannot be increased by adding more drill collars. This case corresponds to the horizontal portions of the diagrams (Figures 4, 5 and 6).

Influence of Hydrostatic Pressure on Buckling

Referring again to Figure 22, it is seen that the buoyancy is equal to the vector sum of forces DE and EF. The force EF is proportional to the hydrostatic pressure. As EF is perpendicular to the shearing force FG, the shearing force is independent of EF, but depends on ED. As stated in the paragraph "Analytical Formulation of the Problem," the force DE may be eliminated from our considerations, by replacing the weight CD by the force CE such that the ratio of CD and DE is equal to the ratio of specific gravities of steel and mud.

Consequently, the shearing force and, therefore, all the buckling characteristics are not dependent on the compression EF which results from the hydrostatic pressure, but do depend on the loss of weight DE of steel in the drilling fluid which is also a result of hydrostatic pressure.

Influence of Pump Pressure on Buckling

The effect of buoyancy on buckling of the drilling string was established with an assumption of a hydrostatic distribution of pressure in the hole. As the mud is actually circulating, a hydrodynamic distribution of pressure should be considered. At any depth, the pressure is larger inside the drill pipe than in the annulus. Let us investigate the influence, if any, of the high inside pressure on the buckling of a drilling string.

Imagine a hydrostatic system **b** (Figure 31) in which the distribution of pressure would be the same as in the hydrodynamic system **a.** The system **a** comprises the pump P, the drilling string D, the bit nozzle N and the annulus A. The equivalent hydrostatic system **b** comprises a drilling string D not communicating on bottom with the annulus A. The hydrostatic pressure increases with depth. In the hydrodynamic system this increase is smaller inside the drilling string and larger in the annulus because of the loss of head due to viscous forces. Therefore, the drilling string of the equivalent hydrostatic system should be filled with a lighter drilling fluid, and, inversely, the annulus with a heavier one.

Let Δ_M designate the density of the drilling fluid.
Let ϕ designate the drop of pressure per unit of length of the drilling string.
Let ϕ_1 designate the drop of pressure per unit of length of the annulus.

The densities of fluids in the equivalent hydrostatic system are:

$\Delta_M (1 - \phi)$ in the drilling string and $\Delta_M (1 + \phi_1)$ in the annulus.

Moreover, the pump pressure of the hydrodynamic system should be replaced by an equivalent head in the hydrostatic system as shown on Figure 31.

Consider the forces acting on a portion of the drilling string between the bit and any cross-section MN (Figure 32). The reaction of the bottom of the hole on the bit, the shearing force and the compression (or tension) in the cross-section MN are like those previously considered, but the weights and buoyancies are different.

The force W is the weight in air of the portion of the string below MN. The force W_1 is the buoyancy acting on the portion of the string below MN supposed completely surrounded by the fluid, i.e., severed from the portion above MN. The force W_1 is then equal to the weight of the fluid of apparent density

$$\Delta_M (1 + \phi_1)$$

and of the volume equal to the volume of the string portion located below MN with the assumption that the string is not hollow.

W_3 is the force which must be added vectorially to W_1 to obtain the true buoyancy because the fluid pressure actually does not act on the cross-section MN.

In other words, the sum of vectors W_1 and W_3 is the resultant force acting on the portion of the string below MN by the fluid of the annulus.

Similarly, the resultant force acting on the portion of the string below MN by the fluid of the drilling string is the sum of vectors W_2 and W_4. W_2 is equal to the weight of the inside fluid located below MN and of apparent density equal to $\Delta_M (1 - \phi)$. W_3 is the pressure inside the drilling string at MN multiplied by the inside cross-sectional area.

By reasoning similar to the one followed previously when analyzing the influence of hydrostatic pressure on buckling, we may say that the compression (or tension) in the string is a function of W_3 and W_4. The internal pressure increases the tension (or decreases the compression) of the drilling string, but the shearing force in MN, and, consequently, the buckling, are independent of W_3 and W_4 because these forces are perpendicular to the cross-section MN.

As far as the buckling is concerned, we must consider only the forces W, W_1 and W_2. Let us consider W_1 as being equal to the following sum:

$$W_1 = W_1' + W_1''$$

Where W_1' is the weight of the fluid of apparent density $\Delta_M (1 + \phi_1)$ and of the volume equal to the volume of the steel below MN, and W_1'' is the weight of the same fluid and of a volume equal to the internal volume of the portion of the string below MN.

The resultant of vertical weights and buoyancies is then equal to:

$$W - W_1 + W_2 = (W - W_1') - (W_1'' - W_2)$$

the expression in the first parenthesis is equal to the weight of steel in fluid of apparent density $\Delta_M (1 + \phi_1)$. The expression in the second parenthesis is equal to the difference of weights of the inside volume filled with fluids of apparent densities equal to $\Delta_M (1 + \phi_1)$ and $\Delta_M (1 - \phi)$ respectively.

This expression may be transformed as follows:

$$W - W_1 + W_2 - V_s \Delta_s k \quad \ldots\ldots\ldots (90)$$

Where V_s and Δ_s are the volume and density of steel, and

$$k = 1 - \frac{1}{\Delta_s}\left[\Delta_M (1 + \phi_1) + \frac{\Delta_M (\phi + \phi_1)}{\left(\frac{D}{d}\right)^2 - 1}\right]$$

Where D and d are the O.D. and I.D. of the drilling string respectively.

The meaning of the last two expressions is that in this investigation, we should have considered the values of weight per foot of strings multiplied by k, and, consequently, somewhat smaller.

The values of drop of pressure ϕ and ϕ_1 per unit of length of pipe and annulus are available. The values of k were then calculated for a few types of drill pipe and drill collars and for various rates of mud flow, and plotted on Figures 33 and 34. These figures were analyzed in Part 1 of this article.

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HERE IS a description of a well engineered and efficiently unitized engine layout plan. The operator has gone so far as to provide rollers on the engine base to assist in loading the unit on truck beds.

BY MAKING up the skids on which his gas engines are mounted as right, left and center, one contractor reduces the amount of shifting required to assemble the power end after a rig shift. Each engine unit is a self-contained assembly, and the engine and all equipment attached thereto are moved with only drives and control and fuel piping having to be disconnected.

When setting up at a new site, the engine sub-base is attached to the derrick substructure and forms an extension thereto. The two outer engines are then moved into place, each being brought in over the center of the support from the side open toward the turnaround ramp. Each engine skid is moved slightly outward from its exact setting so as to allow the third or center skid to be winched into place between the other two. The center skid is then anchored to the sub-base, and the other two skids pulled into close contact and accurate alignment with the center unit through paired 1½-inch bolts working through abutting plates welded to the heavy I-beams which form the side members of the skids.

Access to the alignment plates is through short removable sections of the nonskid flooring, the covers being formed with turned over or rolled edge so as not to offer a hazard to the crew. Short studs and nuts, the studs screwing into nuts welded below the flooring level, allow the cover plates to be placed or removed quickly.

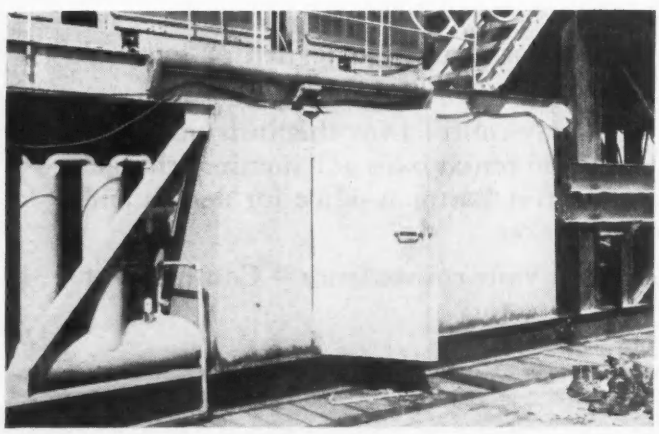
There is sufficient space between the two cover plates to allow visual inspection of the alignment plates, and to allow any slack or play between the abutting faces of these plates to be discovered before damage can occur.

To assist in placing or removing the engine skids, a heavy steel roller is fitted on brackets welded to the outside of the sub-base in front of the center engine. This roller, fitted with pins which work in the brackets, is further supported against the load of the engine skids by a pair of rollers on a support placed midway of the roller.

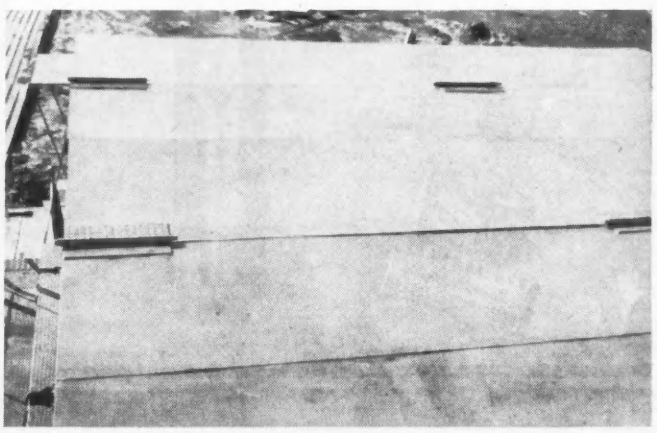
When a unit is to be put on the sub-base, the outer end is lifted from the truck until it rests on the roller, after which the movement of the unit is controlled in part by the winch line, and in part by the angle at which the skid crosses the roller. As this roller is outside the handrail guarding the walk in front of the radiators, it does not offer a hazard to the crew.

Each of the two side units carries a portion of the roof on three rows of two-inch pipe posts which are permanently attached to the I-beams of the skid. Sucker rod braces set at 45 degrees with the roof angles brace roof and post, and provide the necessary rigidity to the unit. Each roof section slopes from the outside upward toward the center engine space.

The inside edges of the roof sections of the two units forming the outside members of the power group carry hinged to them half sections of roof which, when folded outwardly, engage to form a shelter over the center engine. The frames of these two hinged sections fit together closely



Roller bracketed to front I-beam of sub-base facilitates movement of engine skids to and from truck bed. The roller has auxiliary support in center to prevent deflection under concentrated load of engine base unit.



View of a portion of the roof over the power units, showing the hinges which allow divided center section to be folded back over fixed portions on outer engine skids for rig shift. Roof slopes from high center seam.

the Spindletop discovery well

HAS BECOME ALL ITS OWN

History records . . . and many an old-timer is still around to confirm it . . . that mud used in the Spindletop well was actually siphoned from a near-by mud hole, agitated by cows wallowing and trampling through the mire.

Through chemistry, modern drilling muds that play such a vital role in today's deep, high pressure oil well have evolved into a complex, specialized science all their own. The carefully compounded and controlled drilling muds used in deep Gulf Coast wells today, for example, are a far cry from the earth-and-water muds used in early discovery wells that established the Gulf Coast region as one of the world's most prolific oil producing areas.

But with the steadily increasing demands for more and more drilling muds and chemicals, the question of future supplies became an acute problem. Then, in 1941, the producers of Magcobar developed a process for beneficiating ore from a vast deposit at Magnet Cove, Arkansas, and made available many million of tons of the world's finest mud weight for oil well drilling at the low . . . but fair and reasonable . . . price of $22.00 per ton in Gulf Coast fields.

During the past decade, the solutions to many of the oil industry's specialized drilling mud problems have been found by Magcobar chemists. Extensive research laboratory facilities are maintained to support Magcobar field service engineers in developing better muds to do the job and to lower drilling costs.

So, many years after cows mixed mud for the Spindletop discovery well, another new era began in drilling mud history . . . the era of Magcobar's abundant supply of highest quality products, good service and fair and reasonable mud prices. Look for the Magcobar sign when you need mud. More than 300 Magcobar dealers keep mud stocks available night and day.

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when in place, with the steel plating forming the actual roofing extending out over this junction so as to form protection for the joint. As each roof section is lower than the one toward the center from it, water tends to run toward the edges, and the seams are only tack-welded to maintain relative positions of all the plates forming the roof.

For transport, each half of the center section of the roof may be folded back onto the fixed portion of the shelter on the set of posts belonging to that unit, leaving the center engine skid clear of roof and thus more readily accessible for attaching winch or hoisting lines. For added ventilation during the summer, it is possible to raise that one half the hinged portion of the roof which has the overlapping plate so that in effect a continuous louver is formed through which hot air from the power units may rise without chance of it being blown out across the rig floor.

Belt guards for the drives to the two mud pumps are made separable at the edges of the two skids on which they are mounted; the usual practice being to shift the pump toward the power unit skid—or skid toward pump, as is the easier—and to remove the V-belts from the pump sheave, leaving them where they can be pulled in through the back of the guard and coiled down on the flooring of the skid for a rig shift.

Each muffler is more or less permanently attached to the skid of the engine to which it is connected. A frames of two-inch channel are bolted to the skid-corners, and at the top attach to the outer neck or flange of the muffler body. The exhaust pipe, supported fore and aft on the exhaust manifold of the engine, carried the inner end of the muffler. Short ties, welded between A frame and nearest roofing post, tend to stiffen the frame and prevent vibration.

Uniform Railings

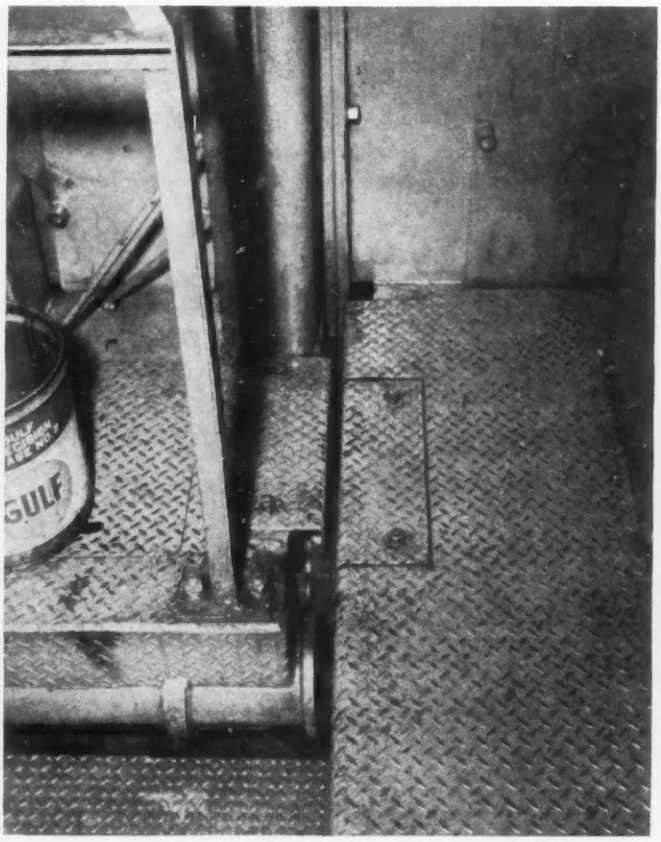
Railings enclosing all walkways are welded from sucker rod, being made up to a single specification for all standard length railings, so that any one may be dropped into place as it comes to hand. The lower ends of the rail posts fit through holes in the upper flange of the I-beams of the sub-base frame, and pass through until the base is in contact with a pad on the inside of the lower flange. The rails are painted a bright yellow to give them maximum visibility. Short, specially built sections close off the ends of walkways. These, too, are readily removed, but usually are carried within the skid when a rig move is being made.

To give maximum adjustability to the rig lights, those intended to light the turnaround, mud pumps, pits and other outside equipment are carried on 2½-inch pipe posts. These posts are mounted on the corners of the sub-base beams, outside the space required for shifting the engine skids during setup or dismantling.

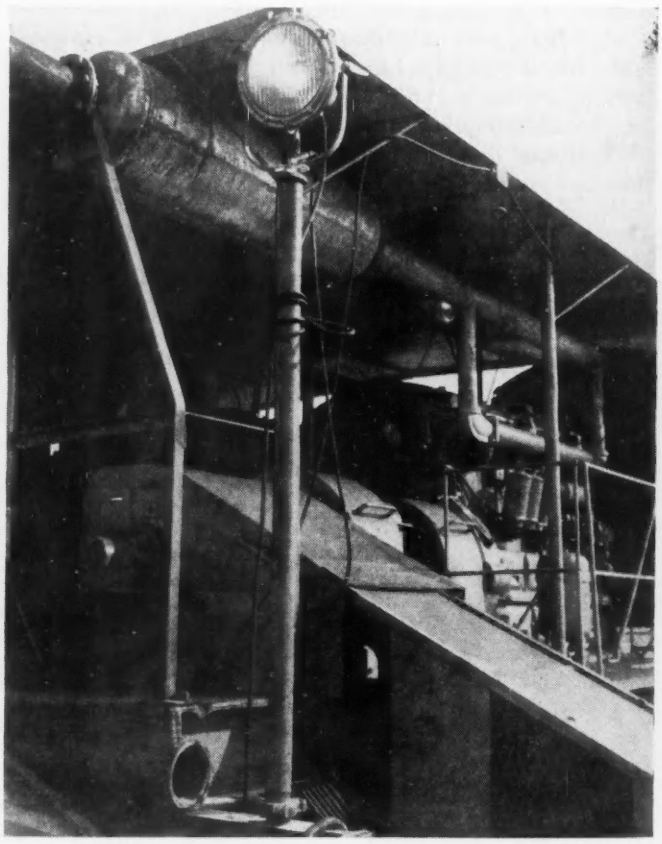
Quick adjustment of the lights in any direction is obtained by equipping the base of each light standard with a hammer-type union, one half being welded to the standard, the other to the sub-base beam. By slacking off slightly on the union, the light may be faced as desired, and as readily locked in place by hammering the union.

The stub of the union remains on the sub-base beam when the post is taken off for a rig shift, the hammer or collar portion of the union being attached to the standard, and thus out of possible damage during the move.

Being movable through a full 360 degrees, these outside lights may easily be rotated so that they add their illumination to the fixed lights under each section of roof when additional light is required, as for emergency engine overhaul.



Close-up of the cover plates in the flooring and a glimpse of the two facing plates and bolts which maintain interrelation of the engine skids when the section is assembled. Turned plates prevent tripping.



Side view of No. 1 engine skid, showing the type of post used to carry unitized roof, muffler support, and method of mounting light standard so that it may be quickly adjusted to face in the desired direction.

Better Designed Pipe Rack

Speeds Rigging-Up

By GILBERT M. WILSON, WORLD OIL Staff

A UNITIZED, simplified pipe rack that can be transported, set up and torn down with comparative ease and in a relatively short while has been developed by Carl B. King Drilling Company, Midland, Texas.

Built in easily transportable, interchangeable sections, the racks readily are adaptable to rough ground, require a minimum of materials for their construction, can be added to easily whenever additional racking capacity is needed, and occupy a minimum amount of space for efficient handling and hauling between locations.

Basic construction of the walkway portion of the rack is similar to that of many such racks, being a boxed section of 4½-inch drill pipe and surfaced with heavy planking. The individual pipe rack sections, however, contain the principal time-saving features. These sections, of all-welded, truss-type construction, are of salvaged drill pipe and 2½-inch tubing. They are of efficient design and have simplified means of attaching them to the walkway end of the section and for leveling to conform with irregularities of the ground. One of these sections, photographed shortly after it had been erected at a new location, is illustrated in Figure 1.

The two horizontal parallel members of the truss are 24-foot lengths of 4½-inch drill pipe. They are spaced 24 inches apart and are braced with 2½-inch pipe, the vertical segments being spaced on 48-inch centers.

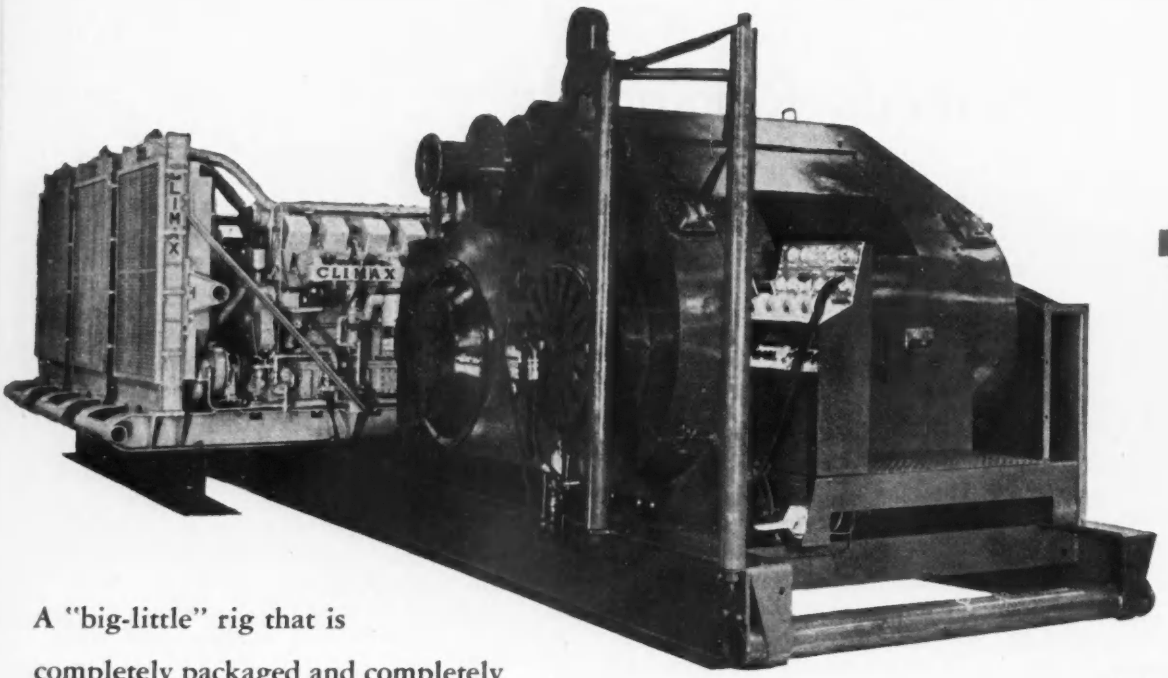
The outer end of the truss section rests on a telescoping single leg which easily can be adjusted to permit leveling that particular rack section and to eliminate having to grade off rough ground that might exist at that point. This telescoping leg is made up of an outer cylinder of six-inch inside diameter pipe and an inner one of 5½-inch outside diameter pipe. A steel pin run through matching holes burned through the two pieces of pipe provides the means of making small adjustments in height. The footing is a broad base made of two 30-inch lengths of 4½-inch drill pipe welded together side by side and in turn, welded to a rectangular flat steel base. Steel plate gussets welded between the leg and base, as illustrated, lend additional rigidity to the unit. Resting the leg on a broad foot-

■ CONTINUED ON PAGE 144

FIGURE 1 (left). This simple truss-type rack section easily is set up and torn down. A hook and key-slot system is used to connect the truss members to the walk rack and the outer end is supported by a single adjustable leg. Provision is made for adding an extra section to the first one merely by hooking the second unit into the outer end of the first.

FIGURE 2 (right). Close-up view showing connection between truss section and walk rack. A hook in the top member of the truss engages a vertical plate welded in the end of the matching stub projecting from the walk rack. To prevent twisting of the truss, a small steel stub on the walk rack portion projects inside a slot provided on the end of the lower member of the truss.

EMSCO *Announces...*



A "big-little" rig that is completely packaged and completely portable has been added to Emsco's famous line of "G" rigs. It's the new GB-800. It retains all of the field-proven features of the "G" rigs. In addition, it gives you these advantages:

- ***Greater operating economy.***
- Reduction in hole-to-hole downtime.
- Drawworks, engines and compounding transmission mounted on a common skid, or as a single-step, two-package unit.
- Simple, easy and fast means of removing and installing engines.
- Clean design that permits cradling of entire unit in the substructure.
- In line and individually-driven mud pump drives located at back of engine compound.
- Totally enclosed, positive pressure lubrication system.
- Drawworks friction clutches located on outboard ends of shafts.
- Console-mounted valve controls at driller's position.
- Large diameter drum.
- Two or three-engine compounding transmission.
- Optional built-in sand reel.
- Optional Emsco auxiliary brake package, dynomatic or hydromatic.

UNMATCHED PORTABILITY

Never has a rig of this horsepower been so completely portable . . . so quick and easy to rig up and tear down!

In the flat set, one-package rig, with drawworks, engines and compounding transmission mounted on a common skid, it is *never* necessary to break chains, oil lines or air lines. In the stair-stepped, two-package rig, only the in-put drive has to be disconnected in moving the rig.

The GB-800 is designed throughout to give you the most in portability and operating efficiency. For specifications and operating details call CONTINENTAL, or write for new Emsco "G" series rig bulletin.

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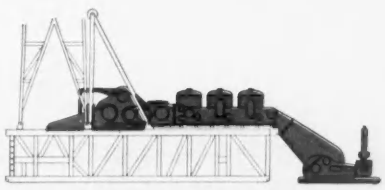
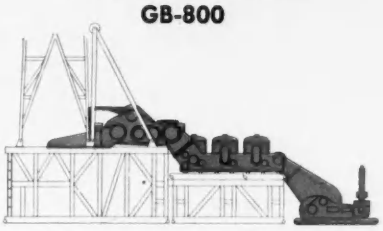
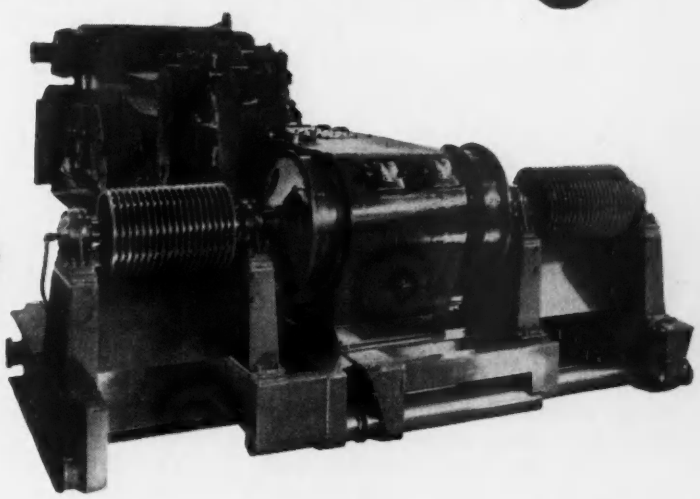
...800 h.p. Skid-Mounted Rig!



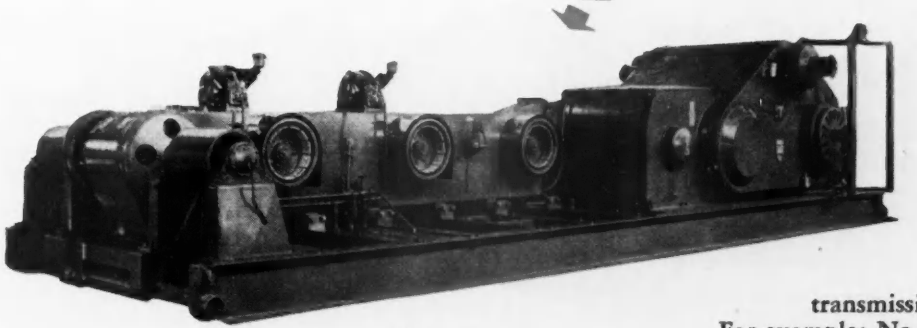
ONE-PACKAGE . . .
flat-set skid-mounted
GB-800



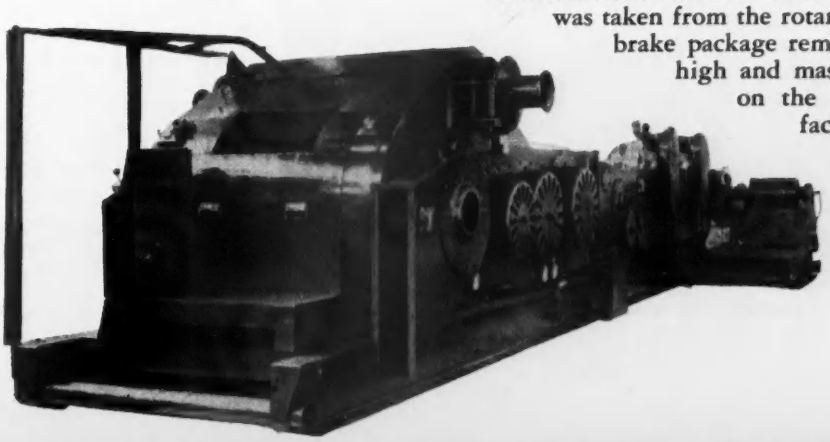
TWO-PACKAGE . . .
single-step GB-800



In Line and Individually Driven Pump Drives. This view shows the double pump drives located at the back of the compounding transmission. The pumps may be driven simultaneously at different speeds. Their position eliminates the need for notching the substructure or using belt idlers, and permits mounting the two pumps in line, simplifying manifolding.



Easier, Faster Engine Installation. Use of Airflex clutches eliminates mechanical connections between the engines and transmission, simplifying the removal and installation of the engines. During this operation it is not necessary to disturb oil lines, air lines or chains. Once aligned, no realignment of the engines is required. Many power flow combinations are possible when a 3-engine, 2-pump compounding transmission is used, such as is pictured here. For example: No. 2 and No. 3 engines may be used, separately, to drive their respective pumps at different speeds, or may be compounded to drive either pump or both pumps.



Clutches Positioned for Easier Maintenance. This photograph was taken from the rotary side, with the Emsco auxiliary brake package removed. It shows the rotary, drum high and master direct air clutches mounted on the outboard ends of the shafts to facilitate maintenance. Also shown is the auxiliary washdown pump drive, provision for driving the Thyrite generator, and the three Emsco herringbone gear-type oil pumps used in pressure lubrication system.

Printed in U. S. A. Adv. No. 110-51

Cantilever Shelter

Protects Rig Power Plant

By JOHN C. ALBRIGHT
Consultant, Santa Monica, Calif.

OVERHEAD protection for the rig engines, at the same time leaving the sides clear for air and observation, is secured by Harbor Drilling Company, Wilmington, Calif., with a novel and well-engineered shelter. Made in sections, no one part is heavy enough to impose a handling problem, the heaviest part being the main or center unit.

The shelter is designed around the center span, which is built in the form of a conventional skid with side members of beam channels. These are fastened together at the ends with lengths of drill pipe, so incorporated as to form the ends of the skid and at the same time provide lateral stiffness to the unit. Transverse ribs between the side members also stiffen the unit, with cross braces of two-inch pipe welded into each end of the skid to further stiffen it against distortion.

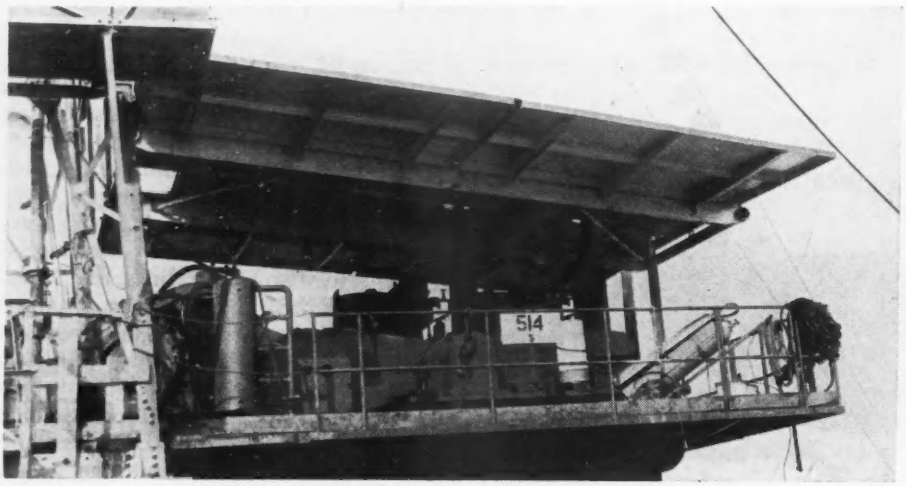
The skid member, designed to be suspended alongside a derrick girt, has two welded loops which carry the eyes of turnbuckles. These, in turn, are connected to the derrick at the next girt by short wire lines, the turnbuckles permitting the end to be readily leveled and adjusted. The outer end of the skid is supported on two posts, each set in shallow cups or sockets welded to the engine substructure. The upper ends of the posts are held in position with ferrules which are welded to the inside face of the roof structure main beams.

The top of the skid member is covered with light weight steel sheet, tackwelded to the skid beams and cross members and in turn serving as further reinforcement for the unit. Lifting eyes, welded to the top of the skid beams through the steel roofing material, enable the unit to be handled with a truck winch line or the derrick line, as desired. Two holes through the center section, in position to permit the exhaust pipes from the engines to pass through, are stiffened with welded-on rings of light steel plate. This reduces corrosion danger at this point and protects the light steel from possible damage while setting up or disassembling.

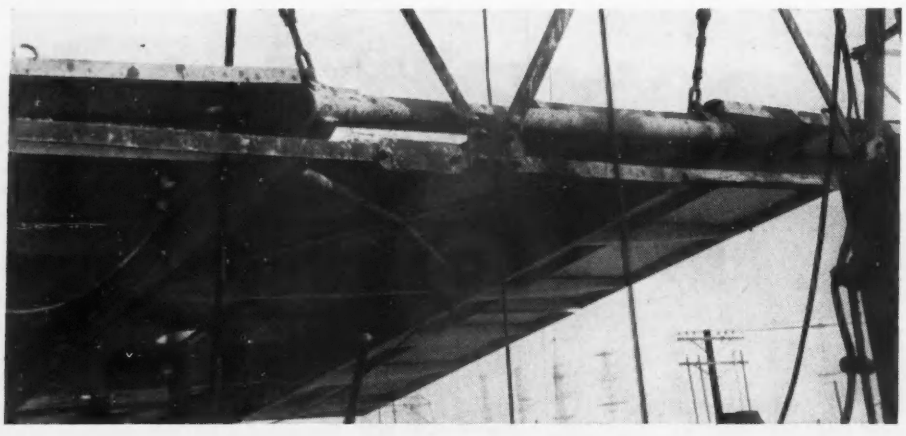
The center or skid section, supported on the two wire lines and the pair of posts, in turn carries two pairs of cantilever roof sections, two each right and left, and all patterned on the same design. Each roof panel is formed with light angle iron ribs and cross braces. To reduce weight still further, the ribs are torch-cut on a taper so that the heel of the rib is of full angle width, while the outer end is only half that dimension. Angle iron braces midway of the ribs add reinforcement, while a second angle of the proper width at the outer ends, forms the support for the roofing steel and completes the panel.

Panels are swung from the channel beams of the mid-section, the two upper units—those nearer the derrick, being placed last so that the downslope edges of their roofing overlap the top edges of the outer panels, thus giving a slope which will effectively carry water across the break and prevent annoying drip on the engines or floor.

The relatively short span of each of the ribs from beam to outer edge is carried by the thrust plate on the heel of the tapered beam against the side channel of the center section. The base of the heel is aligned by a short lug welded to the channel, the



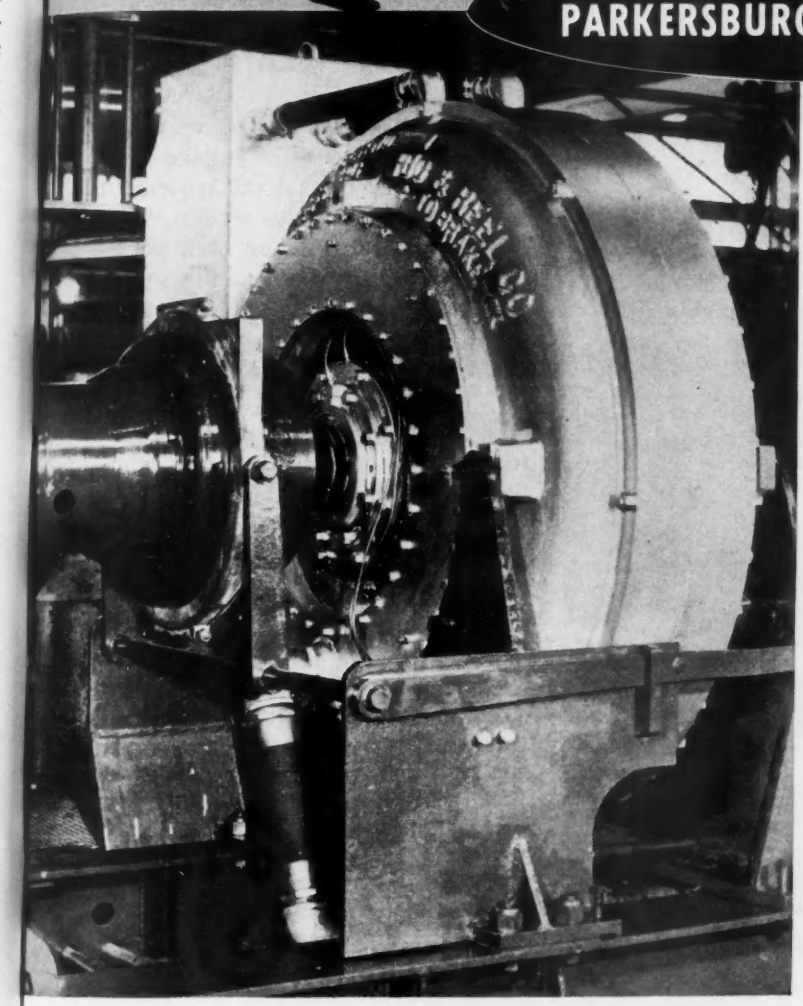
Cantilever design for roof to cover drilling equipment.



Detail of attaching cantilever ribs to main section of roof.

over 30% more BRAKING POWER

PARKERSBURG 46" Super Hydromatic



This "Super 46" is the biggest and most important drawworks brake development of the past 10 years. Actual field tests prove that it delivers OVER 30% MORE POWER THAN THE 40" DOUBLE ROTOR HYDROMATIC. And the "Super 46" costs no more.

The "Super 46" develops 7000 H.P. at 400 R.P.M. and 4700 H.P. at 350 R.P.M. In comparison, the 40" Double Rotor Hydromatic delivers 5000 and 3500 H.P. respectively at the same speeds. Throughout its entire range of speeds, up to 500 R.P.M., the "Super 46" delivers similar increases in braking power. On a drawworks with a drum diameter of 30" and 8 lines, the "Super 46", when operated at full capacity, will hold a 200,000 lb. load to a speed of 90′ in 19 seconds. It packs all the power you need to meet any braking problem encountered in 90% of today's deep drilling operations.

Emsco GB-800 DRILLING RIG is equipped with the new PARKERSBURG 46" SUPER HYDROMATIC BRAKE

Braking power to match the efficiency of this new rig's performance is assured by use of the new 46" Super Hydromatic. It will safely and economically handle any braking problem encountered in the operation of the rig.

You can get immediate delivery on the "Super 46" Hydromatic from your drawworks manufacturer. Or modernize your present rig by installing the "Super 46". It has the same shaft size and taper as the 40" Double Rotor Hydromatic and it can be installed in the field quickly, easily and economically.

Ask your Parkersburg Representative for our new brake bulletin.

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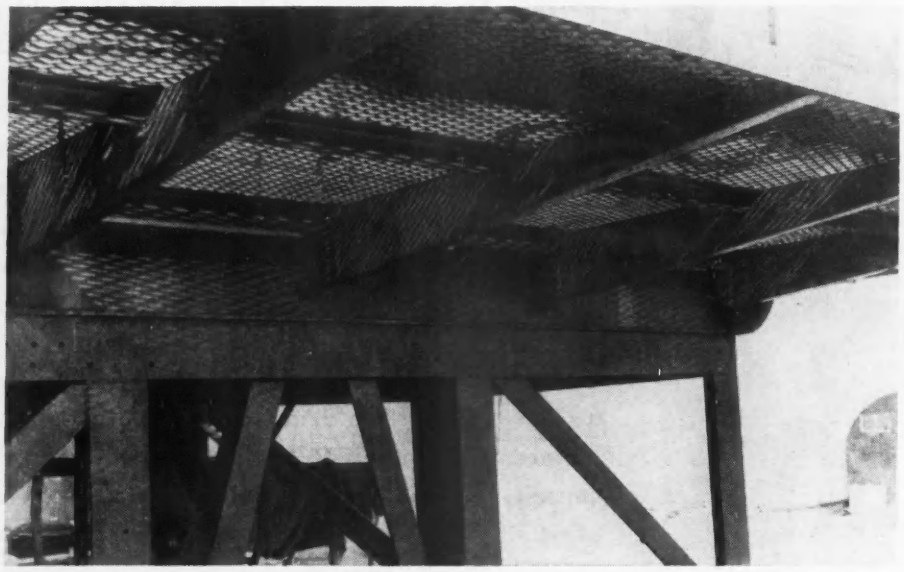
upper end being snugly held by twin ears fitting into sockets welded to the beam. The panel can be removed by lifting the outer edge slightly, and then lifting directly upward. Lifting eyes welded to the upper surface of each panel provide means for attaching a winch line or lifting bridle for the derrick service rope. The panels are light enough so that they can be guided into place by one man who, safely supported on the main or center section, merely has to be sure that all ears are properly aligned, and then to release the lifting line once the unit has settled into place.

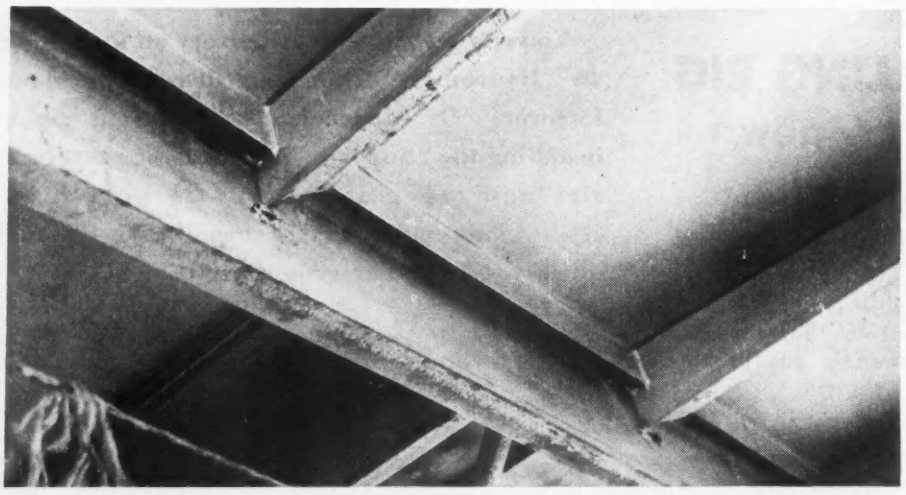
To permit canvas sides to be stretched and thus form a complete enclosure for the power units, a series of light hooks is welded around the inside edge of the facing strip on each panel. These hooks are thus protected from damage when the panels are being moved or placed, and at the same time bring the grommeted top edge of the canvas panels inside the flange formed by the strip and thus make a joint against entry of water.

A flanged hole through the upper panel above the cathead permits the catline to be brought down in a straight line and eliminates the need for extra snatch blocks and consequent added wear on the line. A flange around the aperture stiffens the metal and prevents chafing of the line. Projection of this flange through the roofing metal also provides a guard to prevent drip from water flowing down the panel.

The same type of cantilever ribs which serve to support the roof panel are used to carry the expanded metal catwalk around the engines at floor level. Sections of the floor on the tapered ribs are placed with a winch line or the derrick service line, and are readily removed in the same manner. If the heel supports tend to hang up, as sometimes is the case in a dusty or sandy location, bumping the base of the heel with a short piece of timber will break the lock and allow the unit to be readily picked up.



Derrick end of cantilever roof is supported with two cables and turnbuckles.



Catwalk on engine substructure is designed as a cantilever with ribs attached to top main sill similar to roof section.

Better Designed Pipe Rack

▪ CONTINUED FROM PAGE 139

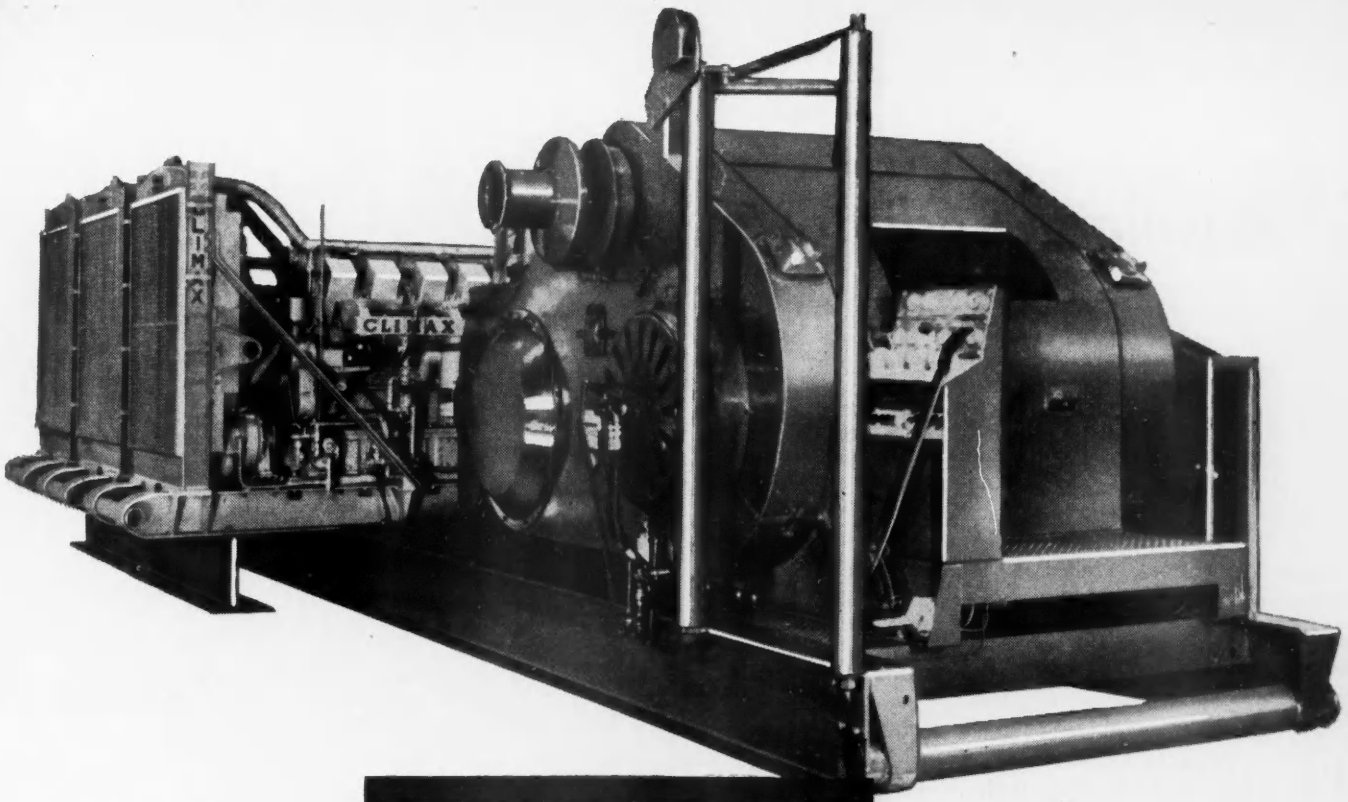
ing of three-inch planking lends additional stability, particularly in areas where ground is soft.

The latching system employed for attaching and supporting the truss section at the walk rack end is very sturdy, yet unusually simple. The top member of the truss has welded in it a 1½-inch thick steel hook which engages a vertical steel plate welded in the end of the matching stub of 4½-inch drill pipe attached to the walk rack. The lower member of the truss has a plate welded in it and in which is burned a vertical slot. A male unit welded into the lower stub of the walk rack section engages this slot and prevents lateral movement or twisting of the truss section. With this type of construction, it is necessary only to lift the truss a few inches above the walk rack level, then slide it down so it can engage the two stub members. Minor adjustments of the leg at the outer end of the truss are made by pulling the pin in the telescoping unit and re-inserting it when the proper height is attained. The close-up view, Figure 2, shows the manner in which the truss is attached to the stubs welded to the walk rack.

As can be seen in Figure 1, the leg of the first truss section is equipped so that a second rack section can be attached whenever necessary. The steel hook in the end of the second rack section engages the open end of the first, and the male member of the first rack engages the slot in the second. The one leg of the first section then becomes the support common to both sections at that point.

Additional racking capacity is obtained by erecting similar rack sections on the other side of the walk rack. The interchangeability feature of the truss sections, together with the ease with which racking area can be added, eliminates the need of racking pipe as high as would be necessary if only single 24-foot sections were employed.

The small amount of space required in stacking the truss sections and the simplified procedure employed in setting them up and leveling them, are features which make this type of rack ideally suited to the streamlined operations wherein comparatively light, jackknife-type rigs are employed. Because the individual truss sections rest on the ground at only one point, a minimum of clearing and general grading is required at that part of the well location.



EMSCO'S GB-800

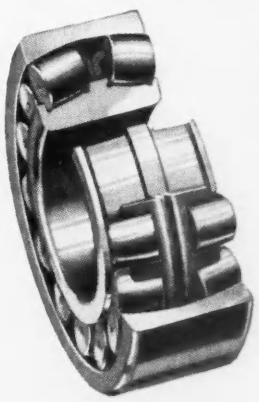
Saves time hole-to-hole

This new 800-hp. rig rounds out Emsco's* line of portable drilling rigs. It can be rigged up and torn down without breaking chains or disconnecting either air or oil lines. The drawworks, with built-in selective transmission, engines and compounding transmission are mounted on a common skid, and can be transported as a unit. Here again, as in so many types of sturdy, hard working oil field equipment, SKF is the choice for bearings. SKF Spherical Roller Bearings are used on all shafts throughout the drawworks, minimize maintenance and downtime. Here again, one more item of proof that SKF engineering helps industry put the right bearing in the right place.

7269

*For complete details on the "G" Series Rigs, write Emsco Derrick & Equipment Co., Houston, Texas.

SKF
BALL AND ROLLER BEARINGS



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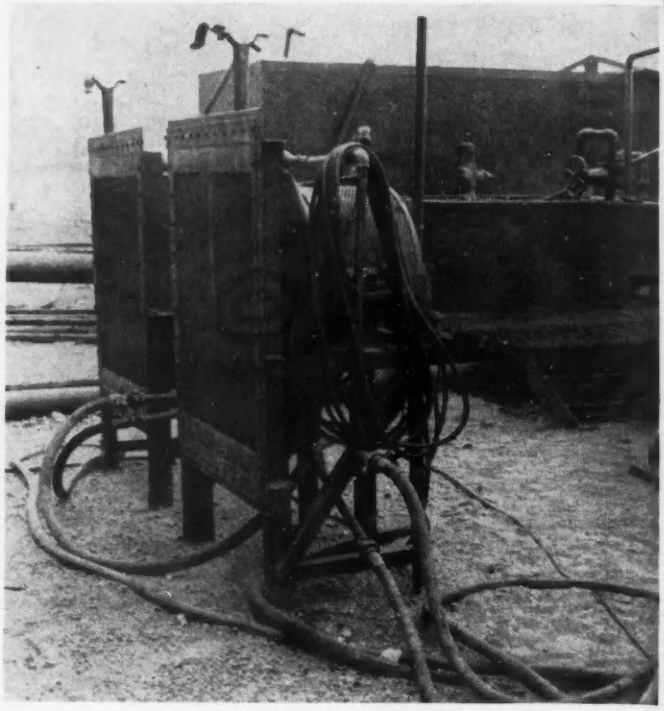
Auxiliary Radiator Cools Gas Engine



Heavy-duty radiators are mounted in an angle iron frame containing a wind-directing shroud and electric motor driven fan to operate as auxiliary radiators for heavy gas engines driving mud pumps, when adverse conditions are encountered.

GAS engine jacket water temperatures frequently exceed the upper limit when the drilling rig is being operated under adverse weather conditions or when the natural atmospheric circulation is blocked off by high cut-banks and other obstructions. A major operator, who obtains production from locations where the rigs are built in man-made pockets or deep canyons, makes provisions for additional cooling facilities for gas engines set in the most unfavorable locations.

These engines are built for normal radiator circulation, and to install these auxiliary cooling units, connections are necessary to remove a split stream of the water from the cylinders and return it to the normal circulating stream. The engines have jacketed exhaust manifolds through which part of the cooling water is circulated by the pumps on the engine and mingles with the cylinder jacket water to pass through the normal radiator.

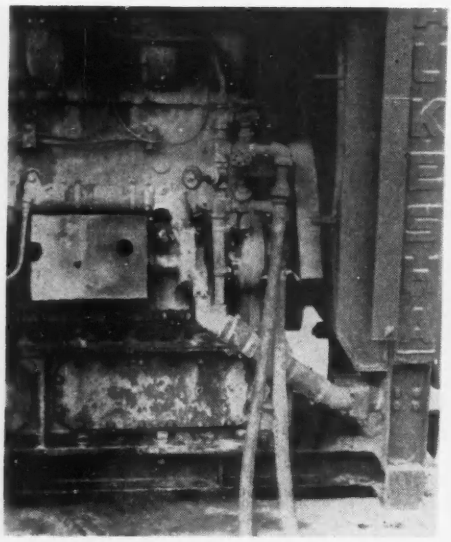
Fittings are usually installed in the water outlet lines leading from the exhaust manifold jackets to the normal radiator. Two nipples, with control valves, are set into the water line, one on each side of a block valve to control the flow of water.

Radiators employed as auxiliary cooling units are obtained from suppliers, or converted by using large capacity truck radiators which are mounted in an angle iron frame designed so the unit may be set up on level ground without the use of cribbing or other special foundations. An electric motor driven fan is placed behind the core of the radiator and surrounded with a shroud to control the flow of air through the radiator fins. The normal filler opening is closed with a water tight cap or soldered shut with a circle of copper or brass.

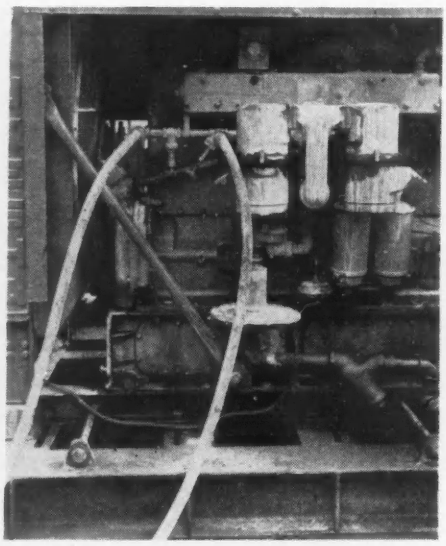
Fittings are attached to the inlet and outlet connections of the radiator to install water hose, the opposite ends of which are connected to the fittings on the exhaust manifold water jacket piping previously prepared. These pieces of hose are long enough so that the auxiliary radiator can be set up in an area where favorable air circulation can be obtained, regardless of the wind direction, when additional cooling is required.

No extra water circulating pumps are necessary to divert the water through the auxiliary unit as the pump on the engine takes care of necessary water travel. No particular attention is required for the successful operation of these auxiliary radiators except to check the water level in the normal radiator to see that an adequate quantity is available.

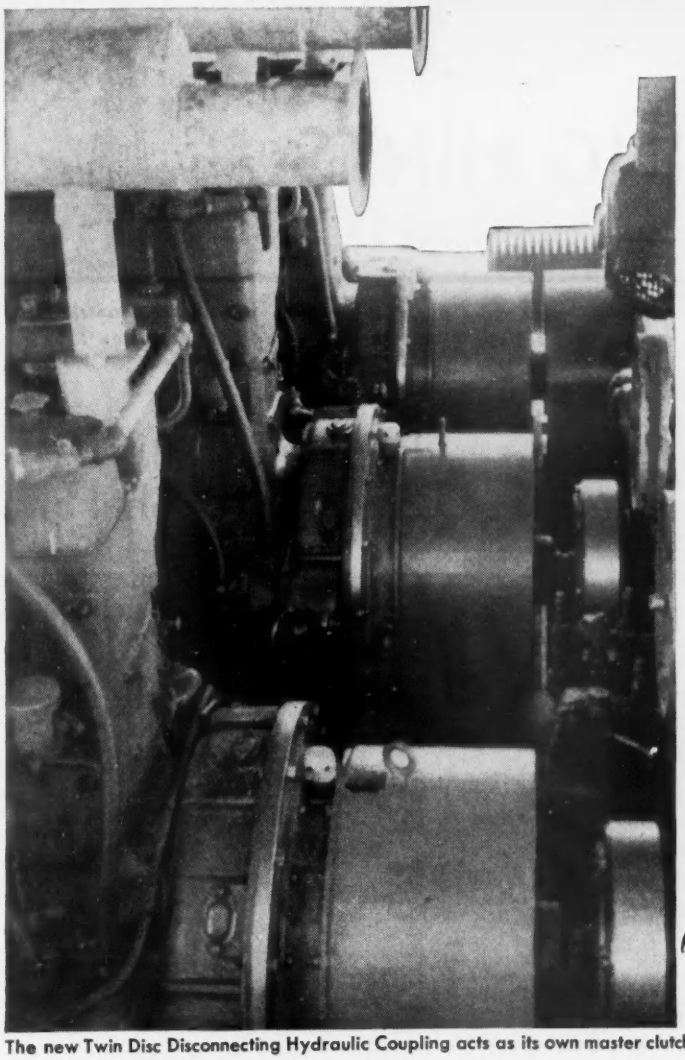
The thermostat on the engine prevents overcooling, if weather conditions should change; however, it might be desirable to pull the plug, or open the switch on the cable supplying power to the auxiliary radiator fan, to increase the jacket water temperature so that free circulation through the normal radiator is maintained.



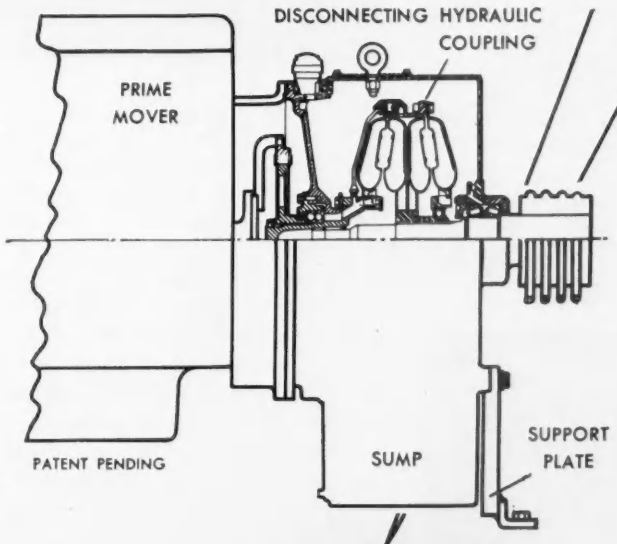
Supply hose connections are attached to piping carrying hot water from exhaust manifold water jacket, leading it to auxiliary radiator and back into same line leading to radiator mounted with pump engine.



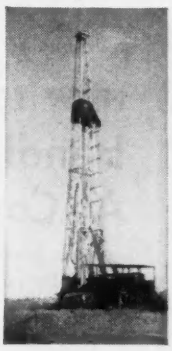
Another type of connection is made for regular use of the auxiliary radiator with take-off at the exhaust pipe water jacket on the manifold side of the engine, where it may be reached with greater convenience.



The new Twin Disc Disconnecting Hydraulic Coupling acts as its own master clutch.



40,000 Feet With No Down-time



Mechanical rigs equipped with the *new* Twin Disc Disconnecting Hydraulic Coupling are *making hole faster*—with far *less maintenance*—than ever before.

Take, for example, the Emsco GA-500 Drawworks, operated by O'Neal Drilling Company in West Texas fields. This rig has been in almost continuous operation since last March, when the HUD Couplings were installed, and, to date, has drilled better than 40,000 feet of hole.

"We have had no chain breaks and practically no chain wear, no clutch, bearing or engine failures since the couplings were installed," reports J. T. O'Neal, Jr.

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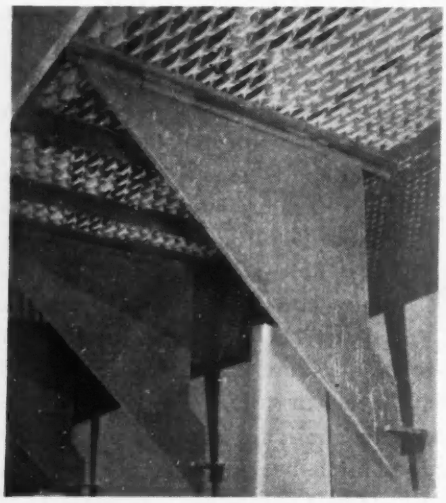
HOW TO—
Add Hinged, Steel Walk to Mud Tank



Fabricated steel, hinged walkways around above-ground mud tanks may be easily constructed and present interesting payout features. A hinged walkway that folds against the tank side for transport should last for many years with intelligent care.

The walkway illustrated, which is attached to the mud tank with bolt type hinges, is constructed of 1½-inch framing covered with non-skid expanded metal. The walkway is supported by quarter-inch plate steel members which brace against the side of the tank. This plate steel support is connected to the underside of the walkway by means of rod type hinges butted against quarter-inch steel straps. The base of the support is held in place with a slotted plate welded against the side of the tank.

Lowering of the unit merely involves lifting the walkway sufficiently high to disengage the support from the slotted plate. Then the support is folded against the bottom of the grilled surface as the walkway is lowered to the side of the mud tank.

Adequate safety features may be provided through the installation of folding guard rails along the frame of the walkway.

Above ground mud tanks should be equipped with sturdy walkways to assist the operation of gunning, blending fibrous material or cleaning the pits. Cost-wise, there may be a certain advantage in the construction of temporary wooden units; however, the expense of installing and removing these temporary structures from location to location soon involves a sizeable investment.

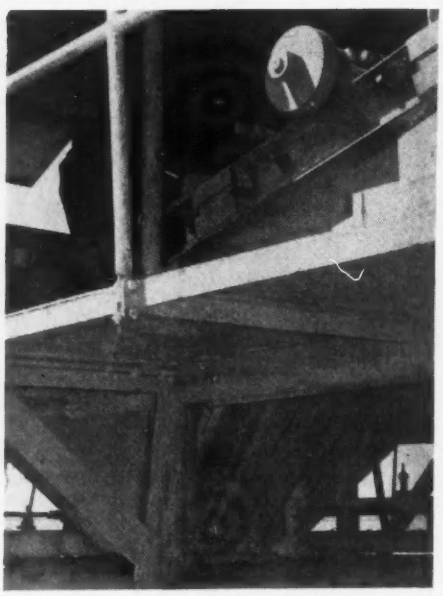
HOW TO—
Handle Mud Guns At Covered Tank

Low, permanent, steel tank shelters, with portholes cut for handling the mud guns, protect weighted drilling fluids during rains, and do not restrict the flexibility and range of the guns.

The heavy sheet metal roof is strong enough to support the weight of crew members operating the guns. With the open porthole, it is possible to rotate the gun in a complete circle. In this manner, every inch of the mud system may be thoroughly gunned or rolled to expedite the removal of entrained gas or mechanically expedite the blending of chemical additives.

A one-inch plate steel flange is welded around the outer edge of the porthole to eliminate the possibility of water draining from the roof into the mud system. The small amount of water which may enter the system directly through the portholes is insignificant.

HOW TO—
Remove Cuttings From Shale Shaker

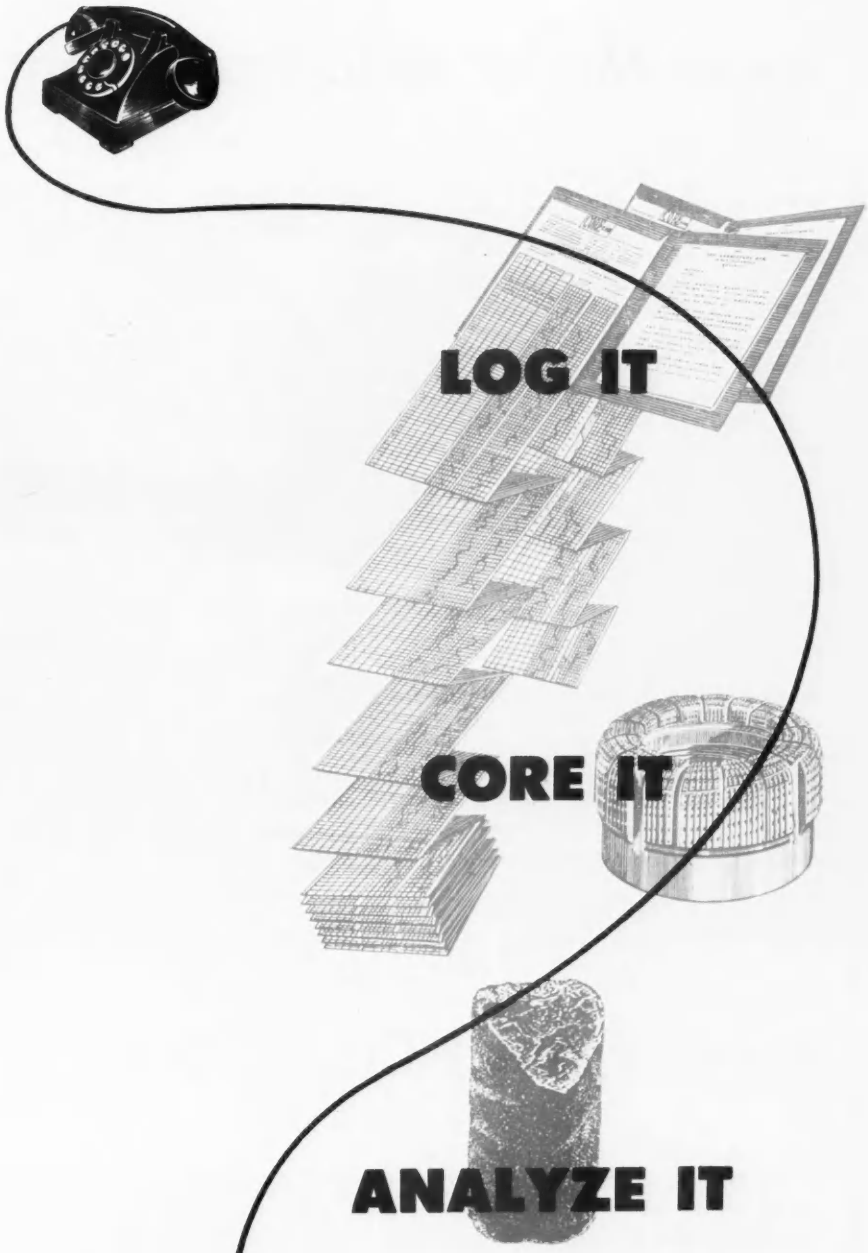


The problem of removing cuttings from the shale shaker may be solved through the installation of a steel jet box. One operator has designed a jet box with angled sides, a one-inch jet line, and a three-inch delivery line to the reserve pits.

The box is installed immediately below the screen to insure the collection of all cuttings delivered by the shaker. Fabrication of the unit incorporates 3/16-inch steel plate side and base units. Effective reinforcement is assured through the placement of angle iron members throughout the structure.

The one-inch jet line has been installed immediately above the base plate of the box. In this manner, shale cuttings may be easily transported from the base of the shaker through the three-inch line to the reserve pit.

The application of this equipment assists in eliminating the accumulation of cuttings at the base of the shaker unit. The advantage of the jet box is increasingly important in areas where thick shale bodies must be penetrated.



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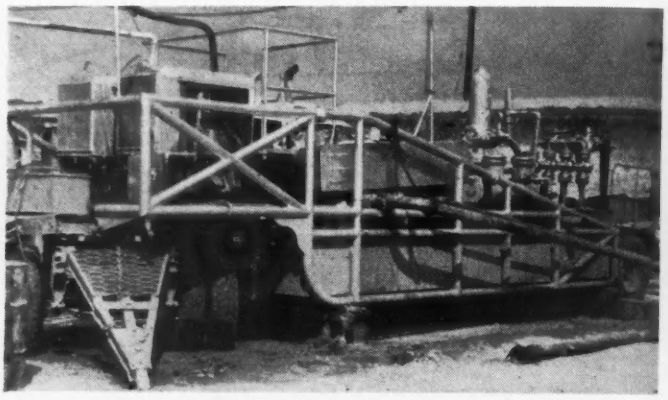
HOW TO—Mount Mud Equipment



A special trailer unit, equipped with mud tank and engine powered pumps, serves a widely flexible purpose on location. It can be employed as an auxiliary mud circulating unit or used to blend special muds quickly without interrupting the rig pump system. The self-contained tank can be pressed into service for the storage of oil base mud, or crude oil used to circulate a fish.

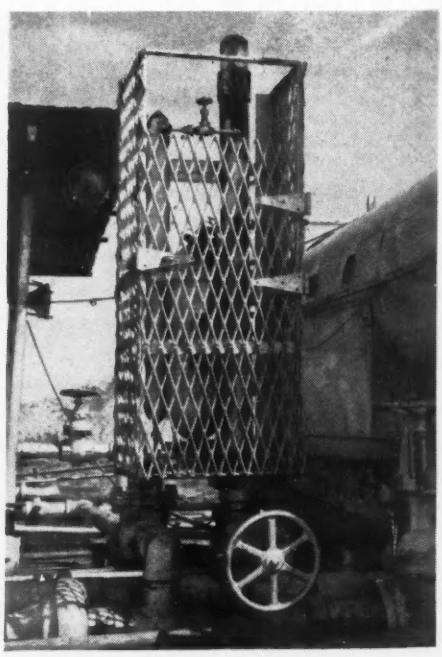
The trailer and accessories are built as a single unit with heavy steel tubing for the frame suspending the storage tank. The chassis is automotive channel iron with the rear axle attached beneath the unit. The front assembly of the trailer is mounted on a fifth wheel and an extension has been provided for towing. The V-8 engines are connected to the reciprocating pumps with a conventional high speed transmission. This gearing mechanism permits the individual or compounded operation of the pumps.

All suction and discharge fittings are equipped with companion unions to couple pipe leading from the tank and hydraulic piping on the rig.

HOW TO—Protect Crew from Burns

The steam lubricator is usually placed in an open, unguarded area where crew members may accidentally brush against the unit and be seriously burned. This problem may be overcome with the installation of an inexpensive box type guard with a hinged opening to permit convenient servicing of the lubricator.

A workable version of the idea incorporates the fabrication of an expanded metal guard around the lubricator. The illustrated lubricator was stationed where danger existed on only three sides. Hence, the operator tack welded angle iron braces across the safe area of the lubricator, extended sucker rod framing from the angle iron, boxed in the front with a swinging door, and covered three sides of the guard with expanded metal. The installation provides the desired safety measure and, with the expanded metal guard, permits sufficient air to circulate around the unit to prevent overheating of the lubricator.



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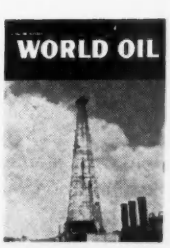

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HOW TO—

Maintain Ready Access to Subs

Subs, kelly cocks and pickup nipples may be safely and conveniently stored on a flat bed, skid type rack. The unit can be placed on the derrick floor to permit easy pickup with the catline.

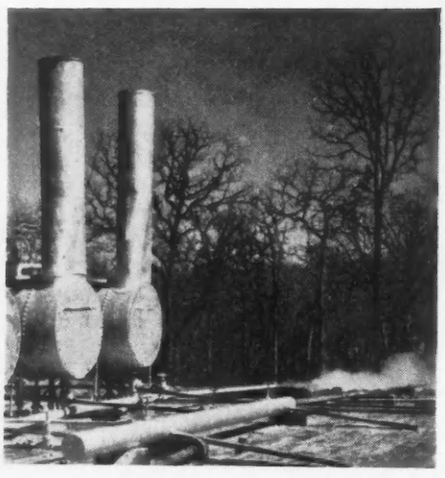
The illustrated sub rack is a welded structure combining I-beam skids, drill pipe end pulls, multisize support pins and a sheet metal covering. Reinforcement under the subs is assured by the placement of additional I-beams.

Adequate protection of expensive subs is afforded by this simple racking device. The storage of subs in this manner permits the immediate drainage of corrosive fluids, easy lubrication of the tool joint and definite insurance against thread damage.

HOW TO—

Reduce Piping On Blowdown Systems

Boiler blowdown systems can be streamlined through the installation of a field fabricated header. The application of this idea is of particular advantage on locations where space is at a premium.



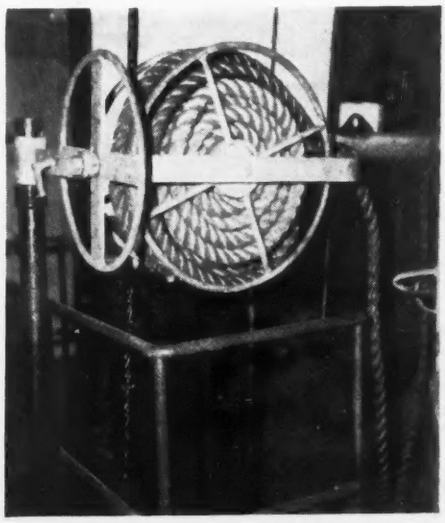
Construction of the manifold includes a welded cap over one end of a joint of 9⅝-inch casing, four two-inch nipples spaced along the side of the pipe to receive the boiler blowdown lines, and a three-inch connection welded in the other end of the joint to accommodate the manifold exhaust line.

A safety feature of the manifold is the presence of a two-inch gate valve at the boiler blowdown line junction. Closing these valves virtually eliminates the possibility of steam leaking by the lever actuated blowdown valve and entering a boiler which has been cutout of the system for repair.

The weight of the 9⅝-inch pipe is sufficient to eliminate the possibility of the header's crawling during the blowdown process. A tendency for the manifold to move away from the boiler during blowdown may be reduced through the placement of timber supports against the side of the unit.

HOW TO—

Keep Catline Free Of Damaging Kinks



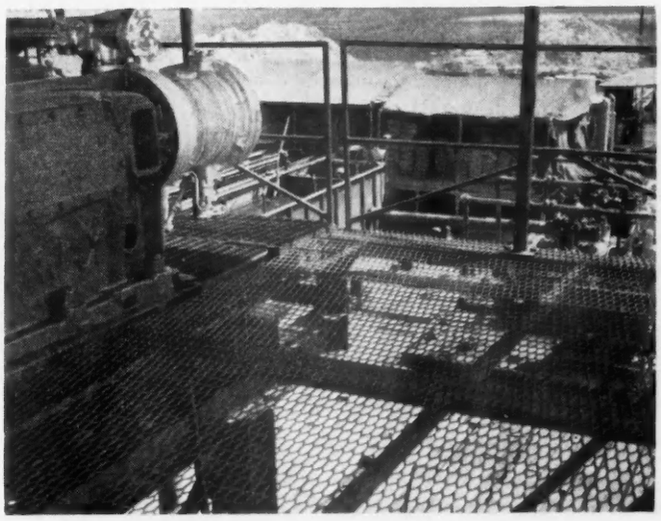
The simple, rotating catline storage reel illustrated greatly extends the service life of the line by eliminating kinks.

Constructed of sucker rod material plus a pipe nipple hub, the shop-made reel is capable of storing 150 feet of 1½-inch line.

Full rotation of the reel is made possible by turning the circular handle, which is on the left side of the unit. The handle can be securely locked in position by means of a steel pin.

The reel is clamped to a two-inch pipe upright which may be placed at any convenient location on the rig floor.

HOW TO—Construct Light Walkway



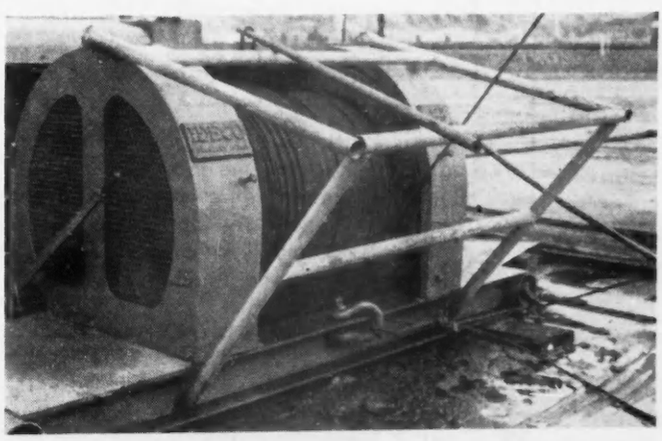
Lightweight, skid-proof engine structure walkways are constructed to expand metal, to facilitate cleaning, rapid assembling and optimum safety. Attached to the top beam of the substructure with bolt hinges, the expanded metal floor becomes a permanent part of the unit. Adequate support of the walkway is assured by four-inch I-beam framing cross-tied with 1½-inch angle iron. The frame is adjusted to the desired level with telescoping two-inch pipe supports which are hinged to the lower beam of the substructure and pin connected to the four-inch I-beam frame.

The walkway is enclosed with welded one-inch pipe guard rails attached to the outer frame by means of lock type hinges. Roof supports, constructed of two-inch pipe, bolt to the frame anchoring the guard rails.

Movable expanded metal frames are stationed immediately below the steam end of the engine to expedite the operation of lowering the cylinder for repair.

Positioning the walkway for rig operation simply involves maneuvering the unit into position with the catline. The expanded metal walkway may be steamed to provide an oil free, safe walking surface for rig personnel.

HOW TO—Guide Sand Line to Reel



A device which can repay itself many times over on a deep drilling well, one that requires only a few pieces of salvaged two-inch pipe for its construction, is a combination spooling guide bar and sand line reel guard railing.

Resting atop the guard rail is a length of pipe which is pivoted under a steel loop welded to the top center of the reel housing. With this bar a man can easily guide the line to assure its being spooled evenly across the full width of the reel. The guard rail serves to prevent anyone from accidentally walking into the reel as the line is being spooled. The guard rail is readily removed and reassembled at the next location.

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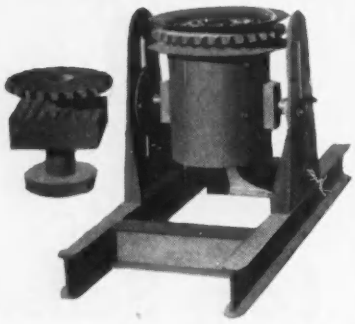

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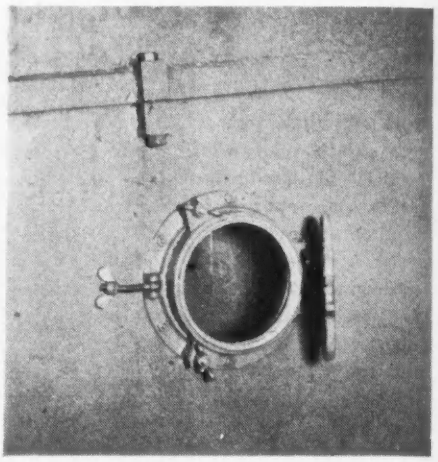
HOW TO—Observe Gear Lubrication

A conventional sealed marine porthole window in the gear box of power mud pumps enables rig personnel to observe the spill of oil on the bull gears. The unit has a cast metal door which may be closed to protect the heavy glass window against possible damage.

The device provides a dramatic demonstration to crew members of the essential purpose oil serves in lubricating and cooling gears. The ability to observe oil spill on the gear train is certainly more impressive than the mere inspection of a dip stick.

Being located on the side of the pump, the inspection port provides a quick and convenient method of watching the lubricant performance within the gear box.

Every power mud pump is equipped with a sufficient number of gauges to determine the quantity of lubricant in the gear box at all times; however, even with these gauging devices present, there have been cases where a gear box lube reservoir has been allowed to run dry, subjecting the equipment to serious damage. Periodic inspection of the dip stock and gear case window will eliminate the failure to maintain proper oil volumes in the unit.



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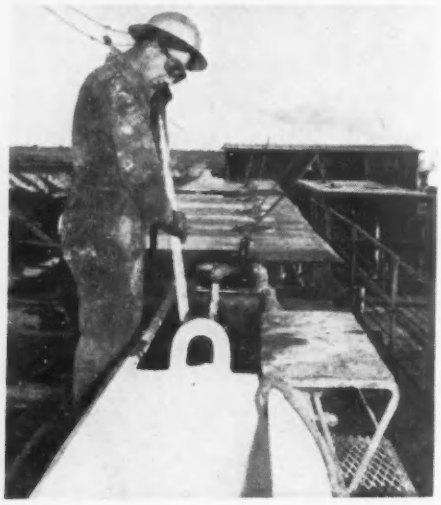
HOW TO—
Handle Chemicals In Mixing Operation



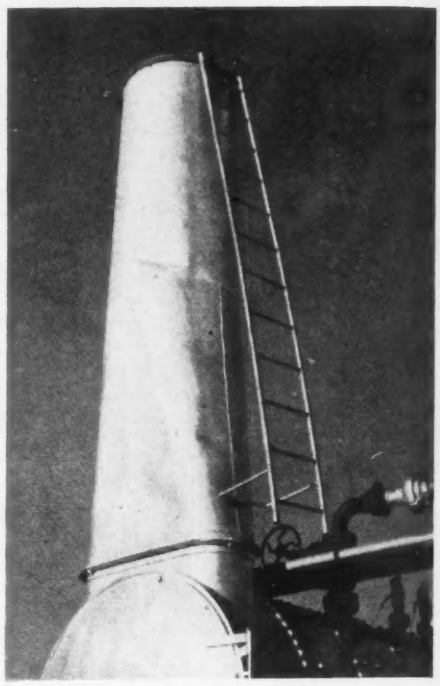
A temporary platform may be constructed of ¾-inch pipe and sheet metal to support bags of mud chemical being mixed in the treating tank. The pipe frame is heated and bent to provide a hook support fitting over the edge of the treating tank. The top section of the rack is covered with sheet metal of a sufficiently heavy gauge to support sacked chemical.

The device offers a definite advantage on location where heavily treated drilling fluids are to be employed. By providing a convenient support for the material, one operator has observed that rig personnel are more patient in the process of slowly adding and blending chemicals which dissolve quite slowly. Caustic soda and other harmful chemicals can be handled and mixed with increased safety when this device or a similar structure is employed.

HOW TO—
Repair Boiler Stack With Greater Safety

The light, sturdy metal ladder illustrated provides a greater measure of safety for crewmen than the make-shift ladders frequently used to gain access to the top of the boiler stack.

The welded ladder is constructed with one-inch pipe legs and one-half-inch steps. The upper sections of the legs have been angled to hook in the top edge of the boiler stack. A one-half-inch horizontal bracket extends from the base of the ladder to brace against the stack. A loose pipe roller has been placd on this bracket to permit easier maneuvering of the ladder into position.



This lightweight ladder may be easily transferred from boiler to boiler for the repair and maintenance of stacks. The flexible utility of the ladder is well illustrated by the fact it may be used to advantage around the boiler barrel, feed pump unit or other low structures on location.

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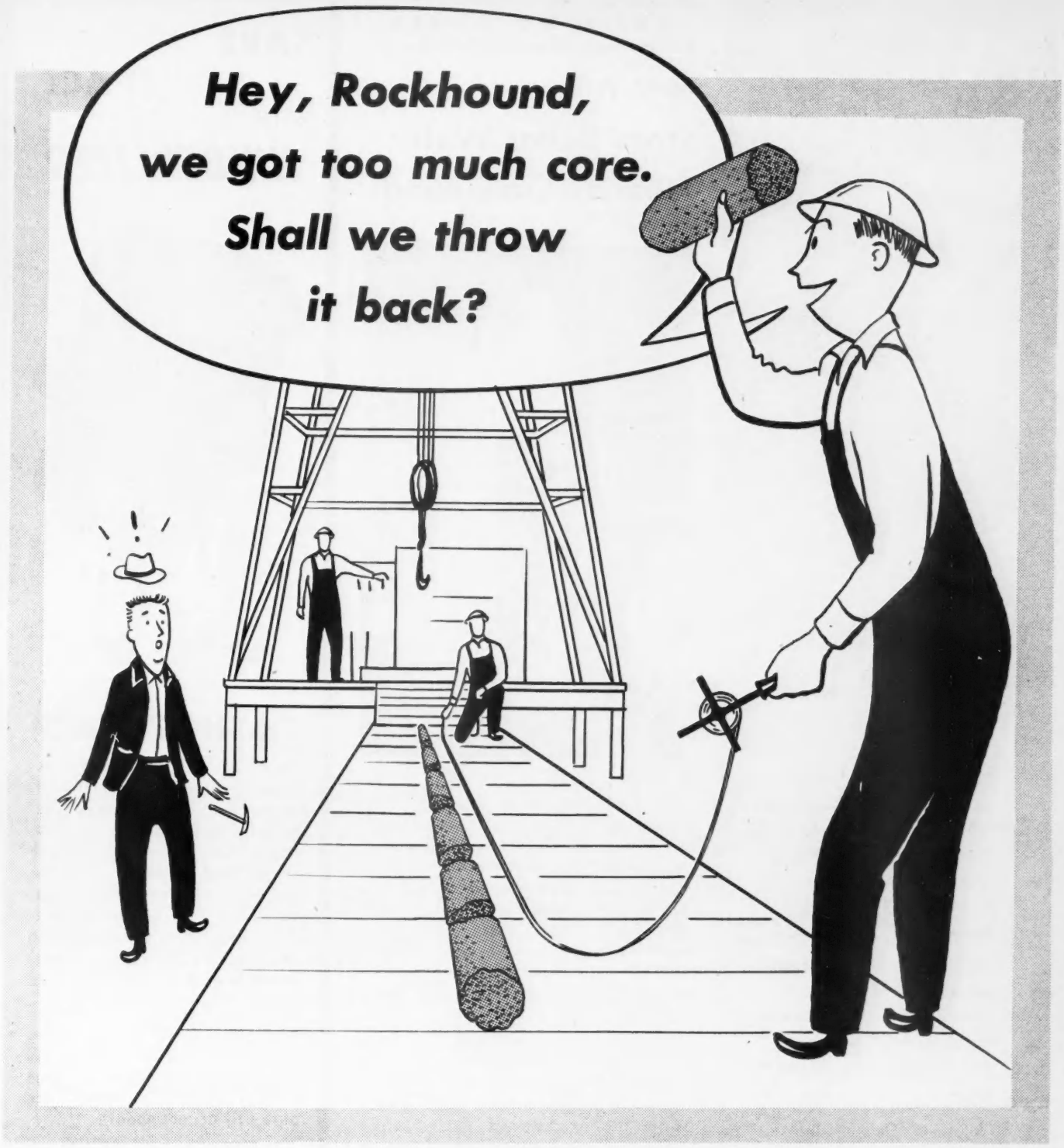

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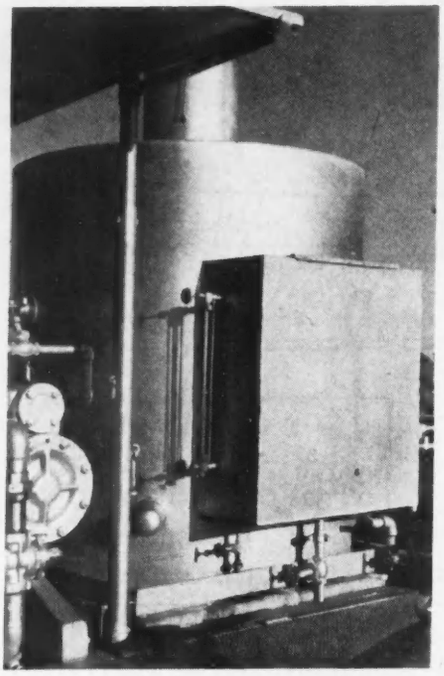
DRILLING HINTS

HOW TO—

Store Boiler Water Treating Compounds



A metal tank can be attached to the preheater unit to store and dispense boiler water treating compounds. One operator designed the illustrated container to eliminate the need for temporary mixing units for blending chemicals. By permanently attaching the unit to the preheater, a neater, more compact container is available.

Constructed of light gauge sheet metal, this welded tank is equipped with a gauge glass, one-inch cold water fill line, and a one-half-inch valve regulated feed line. The turbulence of water entering the base of the unit assists in a more rapid blending of the treating chemicals. The top of the tank is equipped with a hinged door to permit the blending and additional agitation of chemicals. Chemical solution is routed from the storage compartment through the cold water pump, pre-heater, hot water pump and into the boilers.

The container should be so constructed that there is air space between the feed water heater and the chemical tank. Many chemical additives are composed of complex phosphates, hence the solution should not be allowed to heat prior to introduction in the system.

The over-all efficiency of the boiler water program should be somewhat improved by the installation of this inexpensive and convenient feed system.

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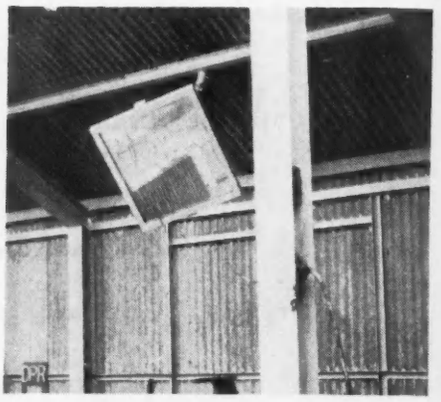
HOW TO—
Assure Unobstructed View of Flow Lines

A large mirror installed over a grilled porthole cut in the derrick floor immediately above the return trough permits the driller to observe the flow of mud with ease. The mirror, which is installed with a flexible pivot system, may be adjusted to permit full view of the mud ditch from the driller's position at the drawworks.

The pattern of the grilled port in the suspended mirror can be seen in the photograph. Adequate lighting facilities beneath the floor permit full vision of the mud flow at all times.

The compact design of the average drilling barge often makes it impossible for the driller to conveniently observe the flow of mud from the return trough. In areas



where there is a constant danger of lost circulation or blowouts, it is essential that the driller be able to watch the flow line. The installation pictured immediately eliminates the necessity of personnel ranging between the drill station and the sub-floor flow line to advise the driller of the circulating characteristics of the drilling fluid.

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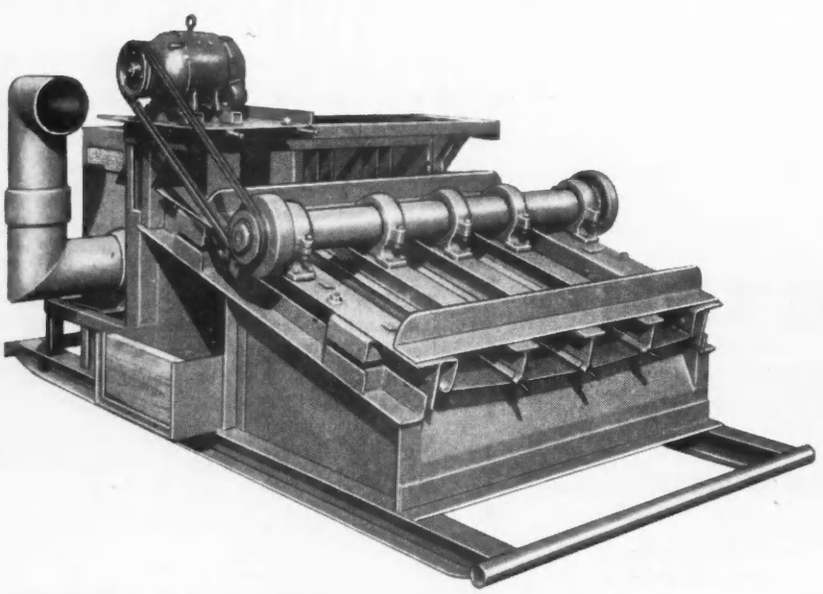
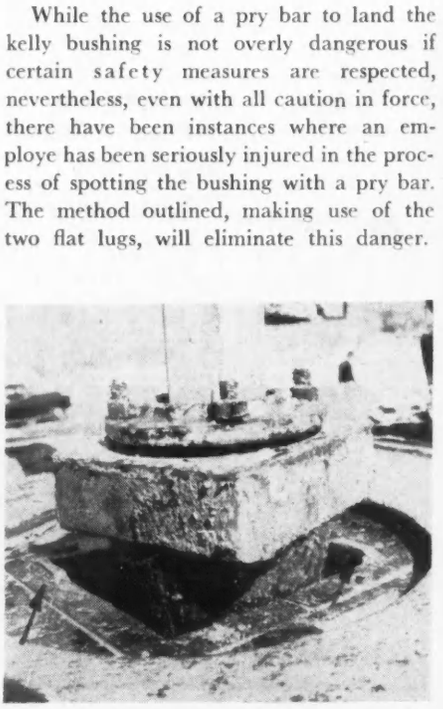
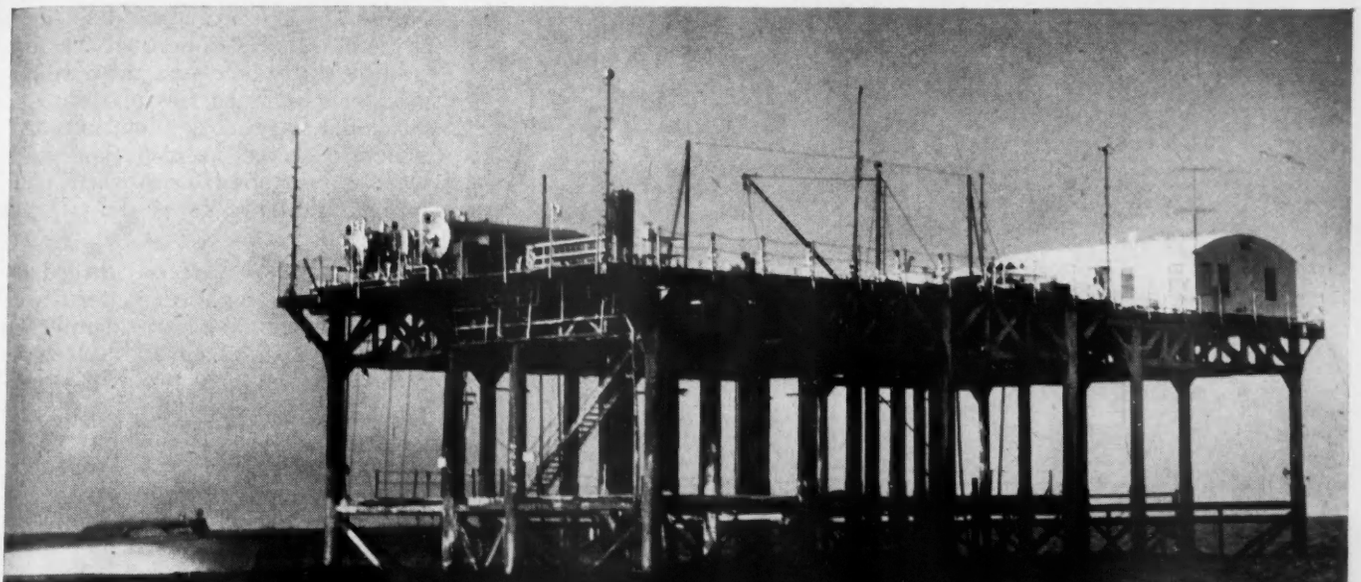


HOW TO—
Center Bushing in Rotary Table Bowl

A novel method of quickly and safely spotting the kelly drive bushing in the rotary table bowl is made possible by welding two flat lugs on opposite sides of the bowl shoulder. To place the drive bushing in the desired position, the table is slowly rotated and the kelly is lowered at a governed rate. As the bushing contacts the welded lugs, the friction established tends to align the bushing and guide it into place.

While the use of a pry bar to land the kelly bushing is not overly dangerous if certain safety measures are respected, nevertheless, even with all caution in force, there have been instances where an employe has been seriously injured in the process of spotting the bushing with a pry bar. The method outlined, making use of the two flat lugs, will eliminate this danger.





Practical Offshore Production Practices At Bay Marchand

By J. E. KASTROP

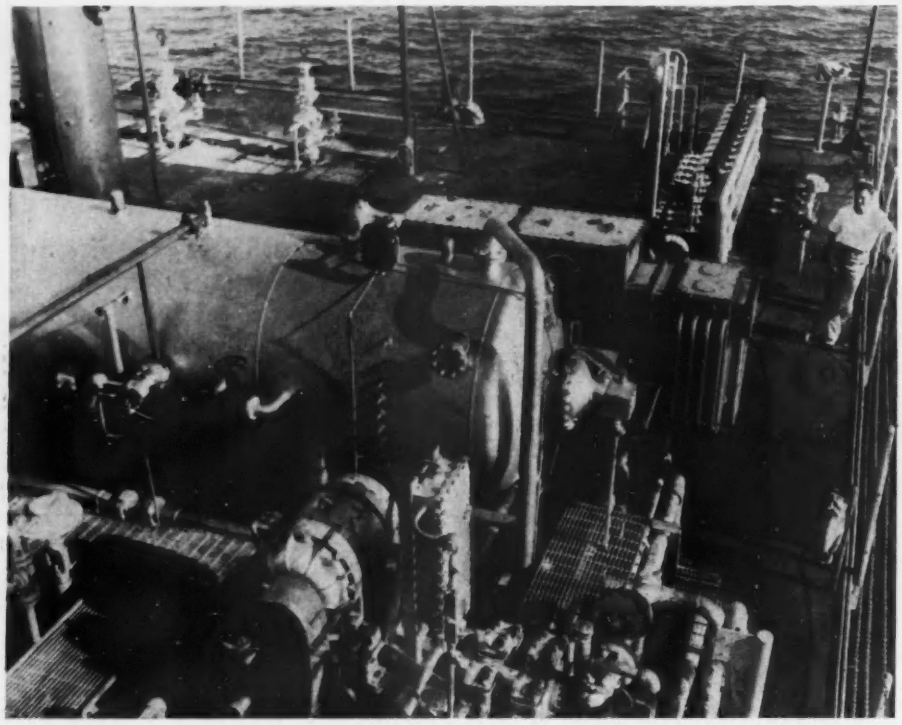
WORLD OIL Staff

PRODUCTION PRACTICES of the most successful offshore oil field yet discovered in the Gulf of Mexico are presented in some detail. Methods of handling oil from the wells, through submarine pipe lines and to shore storage terminals have proven their practicability through hurricanes. Not only are these practices safe and workable; they are also relatively economical considering the magnitude of any offshore operation. What is presented here may provide the solution to similar problems elsewhere.

ONE practical and economical solution to the problems related to handling crude production from offshore fields offers possibilities in marshes or protected inland waters where transportation and topography are major factors. Three miles out in the Gulf of Mexico off the coast of Lafourche Parish in Louisiana, The California Company has adopted production practices which are making possible the efficient operation of the Bay Marchand field. Submarine pipe lines and electric power cables on the Gulf's muddy bottom are the nerve centers of this unusual method of flowing oil from wells situated on steel piling in unprotected water to storage tanks ashore.

The problems of producing oil from an offshore structure proved to be as complex as those of drilling wells in the open waters of the Gulf. Not only was it necessary to set up testing facilities for the initial well, but methods had to be initiated in the early life of the field to handle increasing amounts of oil compatible with the economies of the operation. Production in the early life of the field was barged ashore from central gathering tanks when weather permitted. Later, a four-inch pipe line was laid to shore as production capacity increased, and now there are three four-inch submarine pipe lines that carry an average daily volume of approximately 7500 barrels. Localized squalls and high seas, which are common, plus severe hurricanes which can be expected during the fall season brought about additional problems that were met with techniques providing maximum safety for operating personnel.

TOP PHOTO. Central production platform ("D" structure) in the Bay Marchand field. Living quarters are at extreme right, production equipment at left.



Looking down on the low-pressure bulk unit. In the foreground is the electrically-driven pipe line pump, just beyond the horizontal separator are the transformer and enclosed switches, and in the background are flow lines and production headers.

Current production practices in the Bay Marchand field are the result of an accumulation of experiences in offshore operations combined with a new engineering approach to this unique problem. It was soon learned that weather predictions could not be relied upon 100 percent, and that a fool-proof program must be established to minimize hazards to personnel and equipment in the Gulf.

The satisfactory solution seemed to lie in locating at some protected point ashore as much of the oil-handling equipment as was possible. This essential consideration formed the basis upon which a practical and economical program was worked out.

Since relatively low tubing pressures and some sanding troubles precluded the use of reservoir energy in moving the oil through the submarine pipe lines to shore storage tanks, it was necessary to install a minimum of treating and regulating and pumping equipment on each producing structure in the field. Separators and pressure reducing equipment are located on these platforms, while large-volume capacity heater-treaters were placed at the shore terminal about half a mile from the beach. This site was selected adjacent to Bayou Fourchon (see map) because it offered some protection against storms and because it was accessible to Bayou Lafourche, which connected into the Intercoastal Canal to the north. At the Fourchon Storage Terminal there are located four 10,000-barrel capacity tanks, two heater-treaters, a barge loading dock and a communications shack where a field man remains on duty 24 hours a day.

There are six steel piling structures in the Bay Marchand field. These structures are identified by alphabetical letters in the order of their erection. To date, there are 28 producing wells located on five of these platforms. The first structure, designated as "A" structure, supported the first wildcat, a dry hole, and there are no producing wells on this platform. In the initial stages of development, "A" structure served as a testing point where production from adjacent platforms could be gathered and pumped ashore.

The discovery well was drilled on "B" structure, and encountered salt at a very shallow depth (about 2100 feet). Bay Marchand is said to be located on the largest known piercement type salt dome and consists of 13 separate sands ranging in depth from 2350 to 5700 feet. Pressure in these water-drive reservoirs are normal or near normal. Five of the producing wells receive some artificial aid through gas lift methods, gas for the operation being supplied by the higher pressure wells. Oil gravity in the field varies from 21 to 41 degrees API. Production in the early stages was pipe line oil with no appreciable water; however, some water is now being produced, and is being carried through one of the three submarine pipe lines so that it can be treated at the Fourchon Terminal.

The number of producing wells ranges from three on "B" structure to 11 on "D" structure. As shown in Figure 1, the location of four-inch submarine pipe lines provides some flexibility in moving production from the field to the storage tanks ashore. A four-inch line connects "F" structure with "B" structure, which in turn is tied into "C" and "D" struc-

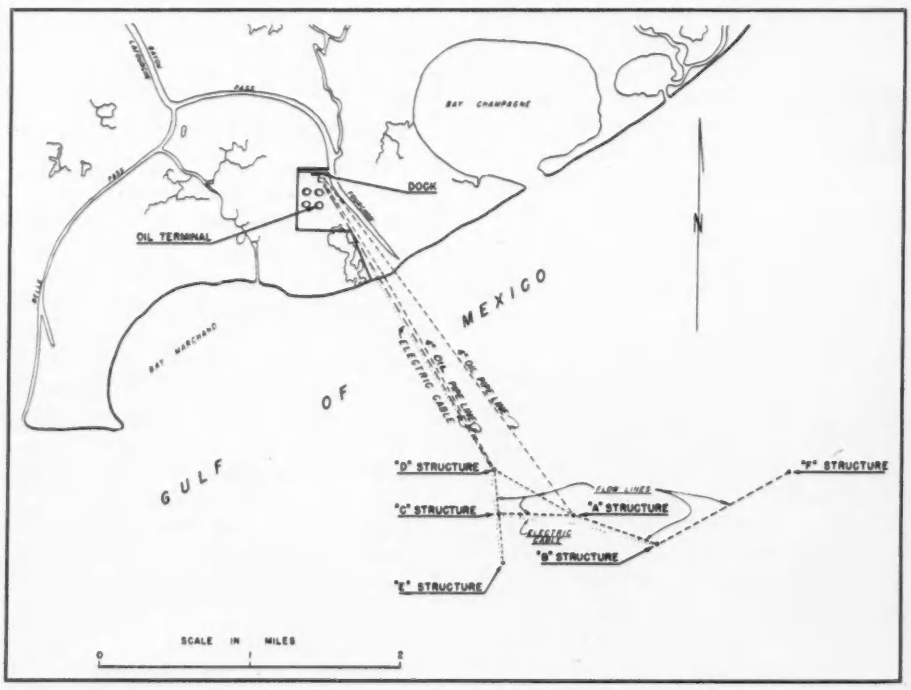
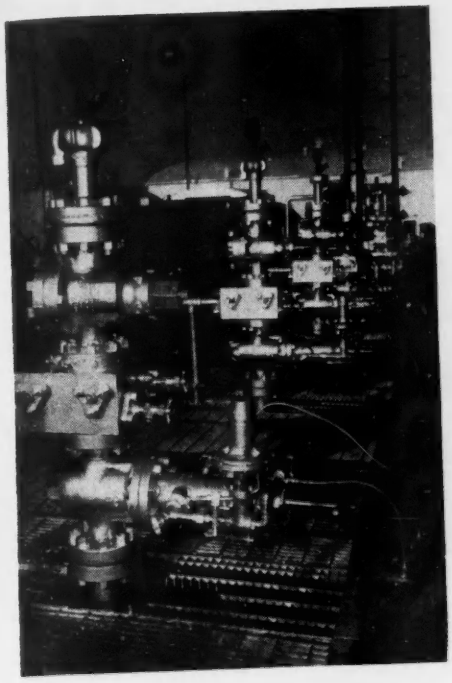


FIGURE 1. Relationship of the producing structures to each other and to the storage terminal is shown on this generalized map. Field headquarters are farther up Bayou Lafourche.



LEFT. Battery of christmas trees of six producing wells on one side of "D" structure. The piston operated, master gate valve is shown on bottom.

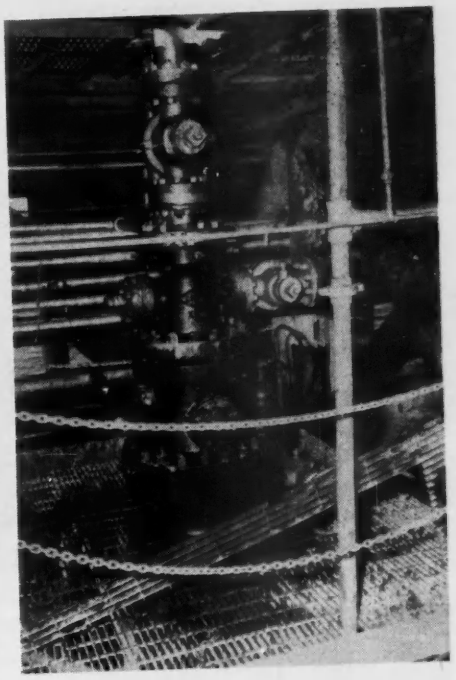
RIGHT. Below deck view of typical wellhead installation.

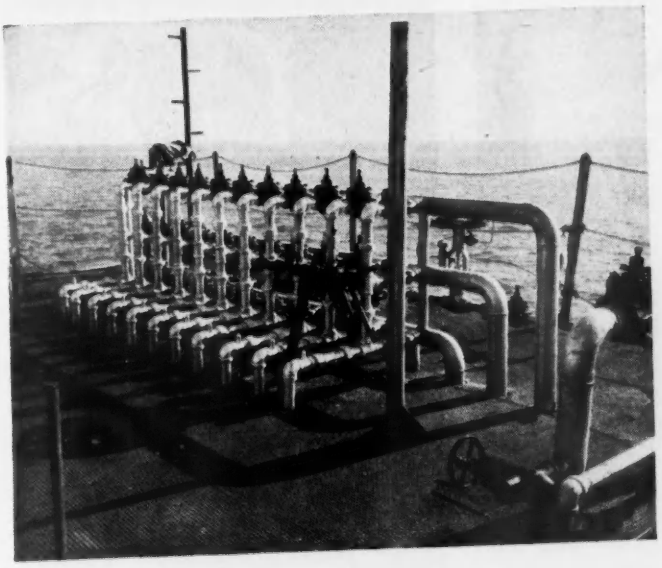
CENTER LEFT. Flow line manifold where each well connects into the three headers to control the flow of oil through the production equipment.

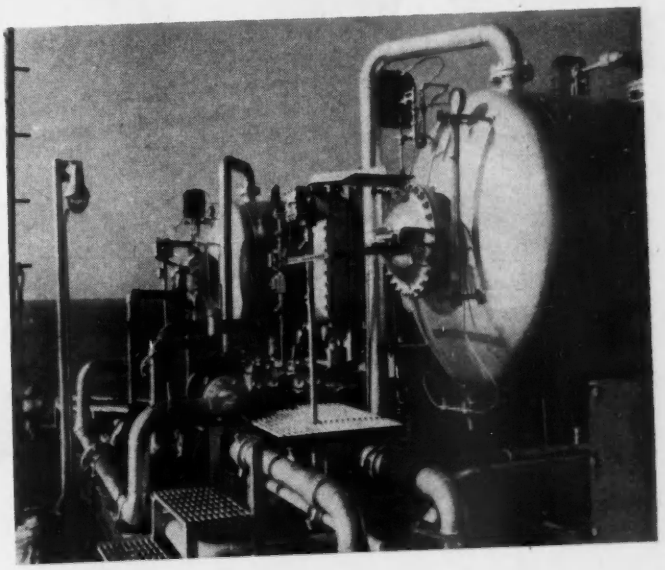
CENTER RIGHT. Control end of the low-pressure separator bulk unit showing arrangement of piping.

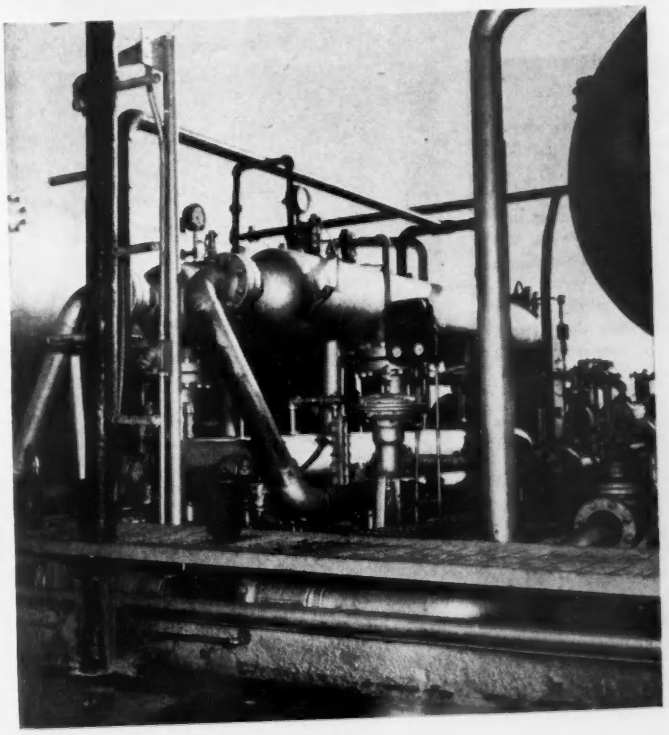
BOTTOM LEFT. High-pressure separator located between the two horizontal units.

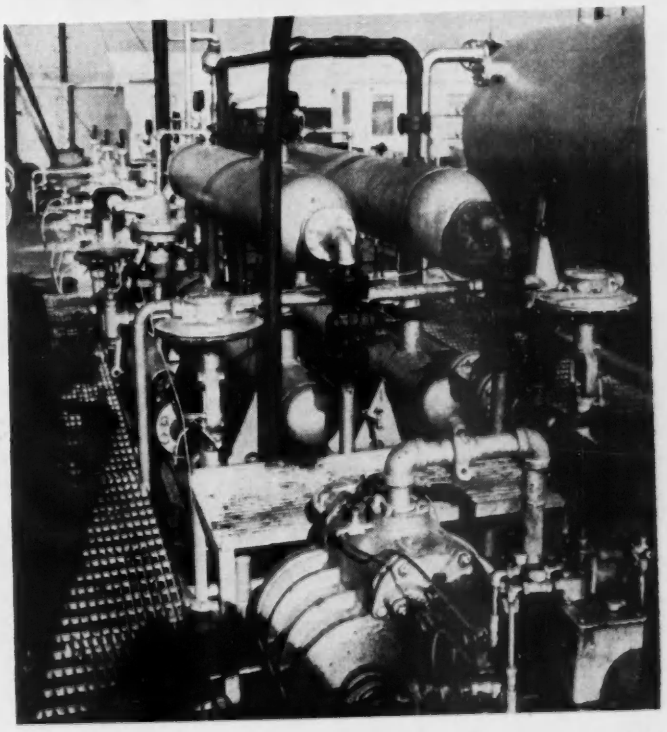
BOTTOM RIGHT. Front view of high-pressure separators looking over power end of the steam-type pump used in connection with test unit.

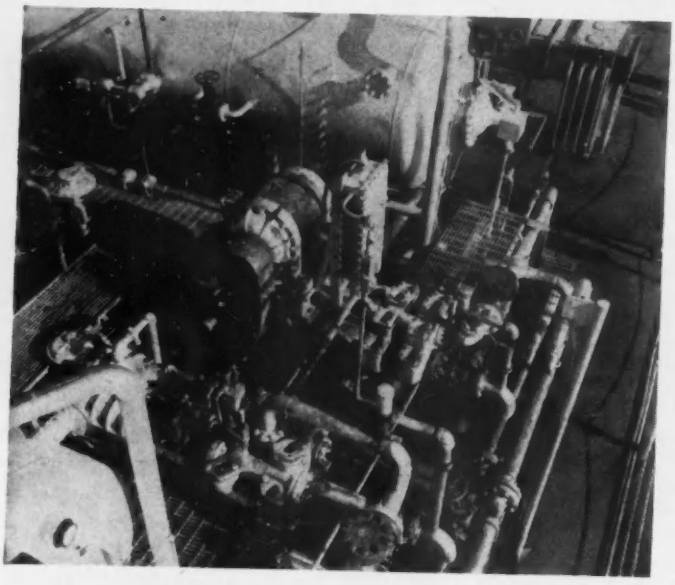


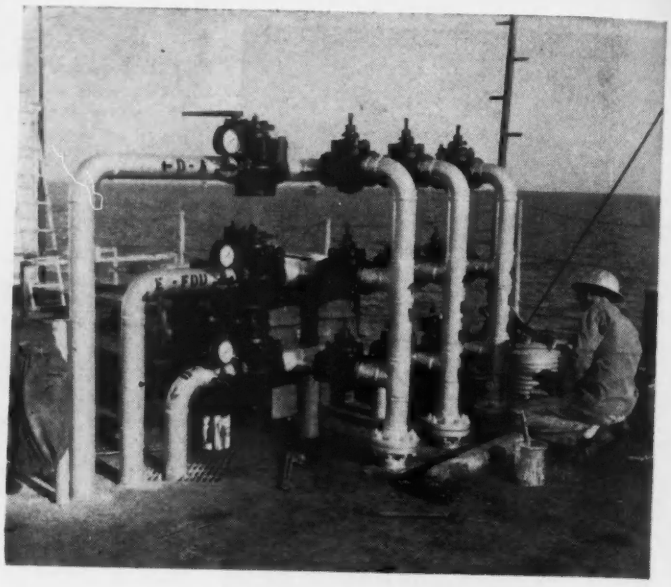


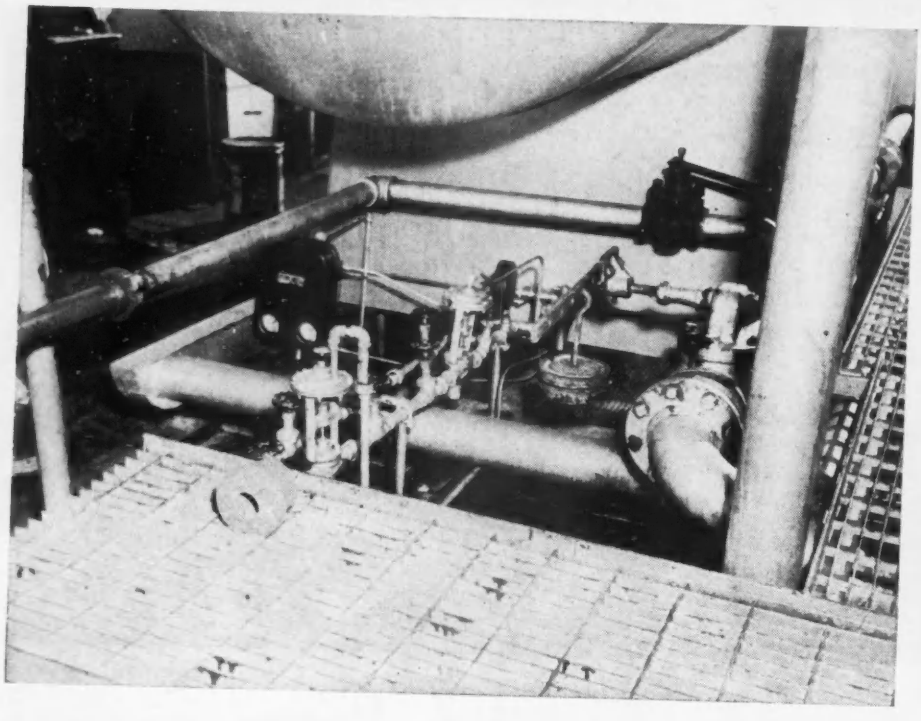


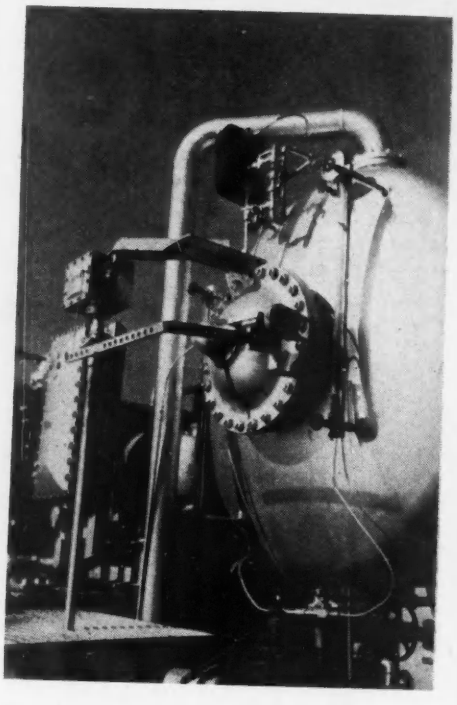


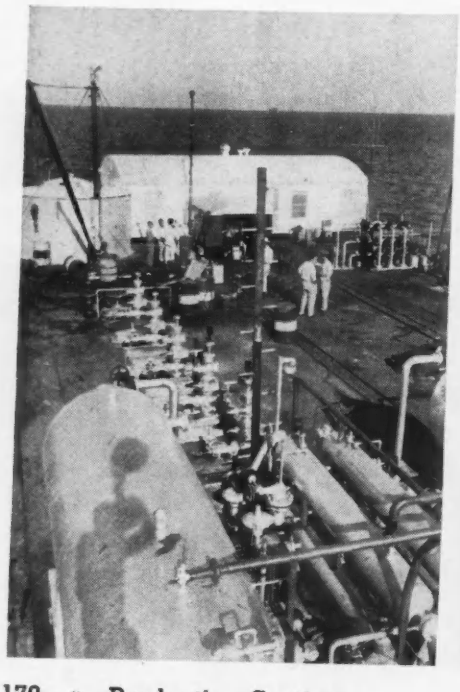












TOP LEFT. Both pipe line pumps are shown between horizontal separators and just forward of the high-pressure separator.

TOP RIGHT. Four-inch pipe line manifold located on "D" structure from which the flow of oil from the field can be controlled.

CENTER LEFT. Heart of the pilot control system are these two three-way diaphragm valves which bleed off gas pressure in the system to close in all wells on the platform.

CENTER RIGHT. Fulcrum arm from oil sump float is attached to the mercury switch enclosed in a metal box.

BOTTOM LEFT. Generalized view of "D" structure.

BOTTOM RIGHT. Production enters Fourchon storage terminal through these four-inch lines. Smaller, two-inch line carries gas from field to supply heater-treaters with fuel.

tures with other four-inch lines. A separate four-inch submarine pipe extends from "A" structure to the storage terminal. Structures "E," "C" and "D" are connected with a similar line, and there are two 4-inch lines from "D" structure to the storage terminal on Bayou Fourchon. A pipe line manifold on "D" structure permits the control of production from "A," "C" and "D" structures. Although "A" structure has no producing wells, it was equipped with separation and tank equipment during the early life of the field. It served as a test battery as well as a storage point for gathering the oil and pumping it ashore. A high-pressure separator there supplied the gas need for gas-lifting wells on "B" structure.

Electric Power System

A submarine electric cable connects to a public utility outlet near the beach and leads to "D" structure as shown on the map. Through similar cables laid on the Gulf's floor, electricity is supplied to other structures. From "D" structure, the supply of electric power to the remaining platforms is controlled by means of transformers and switches. Electric power is used to drive the oil pumps on each structure and to furnish power for other utility purposes, such as lights, motors, etc. Its primary job, however, is to power the pumps which move the oil ashore. This method proved to be not only safe, practical and economical, but it serves as a means of remotely shutting in every well in the field from the shore transformer station.

Electric power was used in the later development stages of the field for both drilling and production operations. At present, however, it serves only the latter phase, since all drilling has been discontinued due to the tidelands controversy. Electricity is available, in sufficient voltage at each structure, to supply power for future workover rigs that may be required, and thereby promises to lower such costs.

The submarine power cable is shown in cross-section in Figure 2. It consists of three multistrand copper conductors capable of transmitting 2500 horsepower to the offshore structure. It is three inches in diameter and weighs nine pounds per foot. More than 19,000 feet were required for this installation. Three pairs of telephone conductors are included in the cable, and these wires may be used for communications or for con-

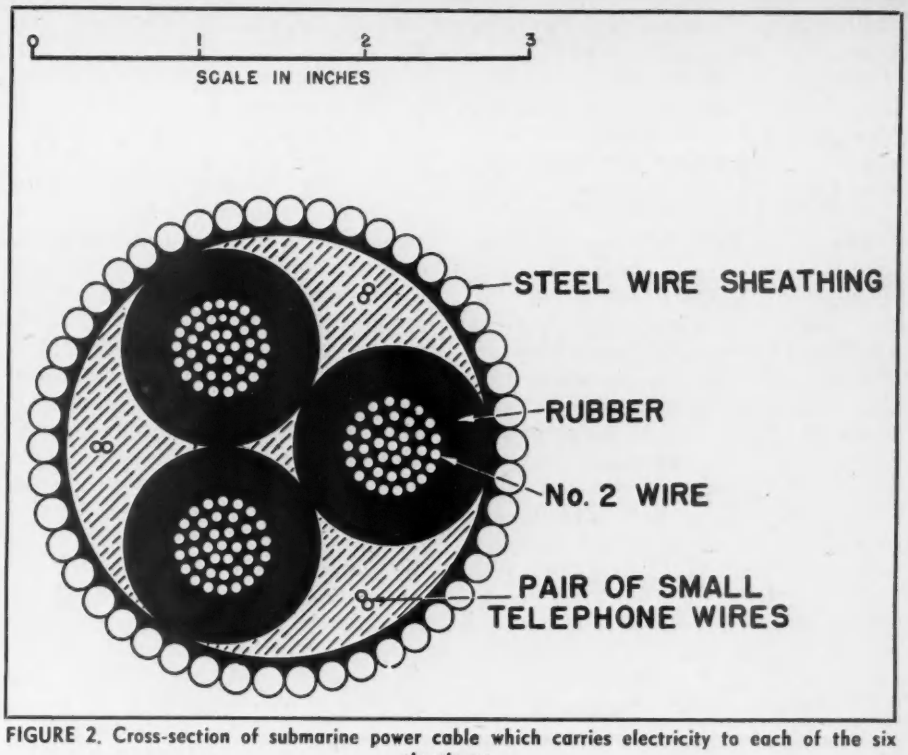


FIGURE 2. Cross-section of submarine power cable which carries electricity to each of the six structures.

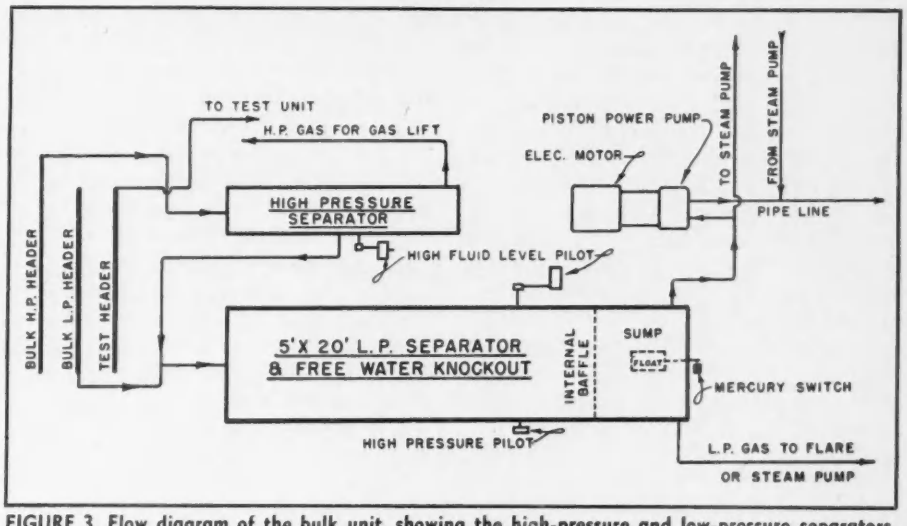


FIGURE 3. Flow diagram of the bulk unit, showing the high-pressure and low-pressure separators, and electrically-powered pump.

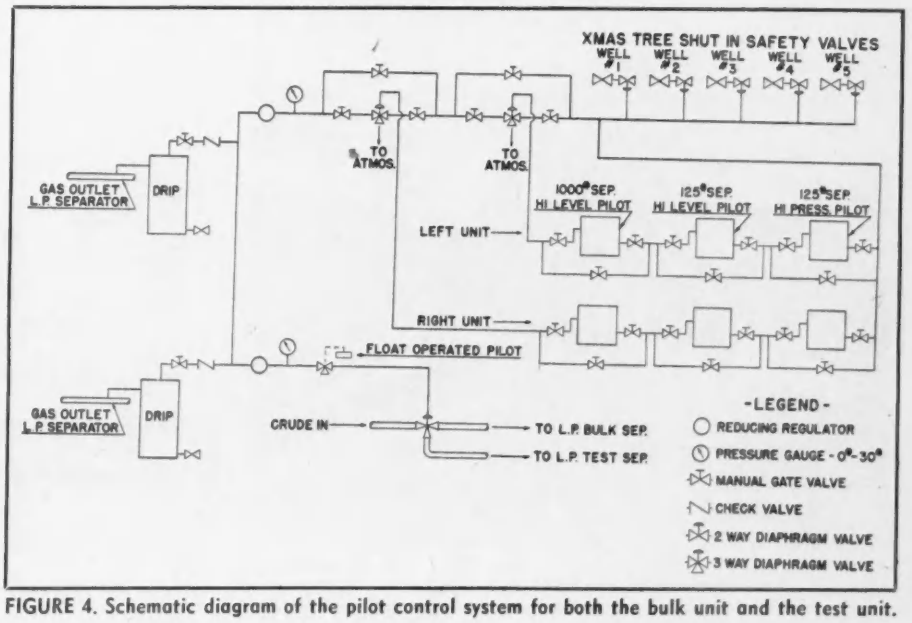


FIGURE 4. Schematic diagram of the pilot control system for both the bulk unit and the test unit.

trolling devices when and if the need arises. At present, two-way radio serves as a means of communications between platforms and shore stations. Most of the vessels used in connection with operating the field are equipped with two-way radio facilities.

The power cable is water tight and is well armored with galvanized steel strands which carry any tension in the cable as well as protect it from chafing. Three-phase, alternating current electric power is transmitted by this submarine cable at 13,800 volts. Each structure is equipped with water-tight transformers, switches and explosion-proof fittings. The transformers drop the voltage to 480 volts for use on the structure. Switches and equipment which may be subject to arcing have been enclosed in explosion-proof housing and submerged in oil.

Details of "D" Structure

Production equipment on each platform has been more or less standardized, and since "D" structure not only has the largest number of wells on it, but also contains the pipe line manifold and living quarters for pumpers and roustabouts, it will be described somewhat in detail. Each of the 11 wells on "D" structure is designated by number and ties into a three-header manifold. Through this manifold, the flow of fluids from any one or any group of wells can be diverted into any one of the three headers. One header delivers production to a high-pressure separator; another connects to a low-pressure, horizontal separator, and a third discharges into a test separator which is identical to the low-pressure unit (Figure 3). Since wells completed in different reservoirs have different flowing pressures, it was necessary to direct the flow of the higher pressure wells into the high-pressure separator. Other wells of sufficiently low pressure flowed directly into the low-pressure separator. Oil from the high-pressure unit discharges through a pressure regulating valve into the low-pressure separator where it comingles with fluid from the lower pressure wells. The high-pressure unit dumps its oil when the fluid level inside reaches a predetermined point.

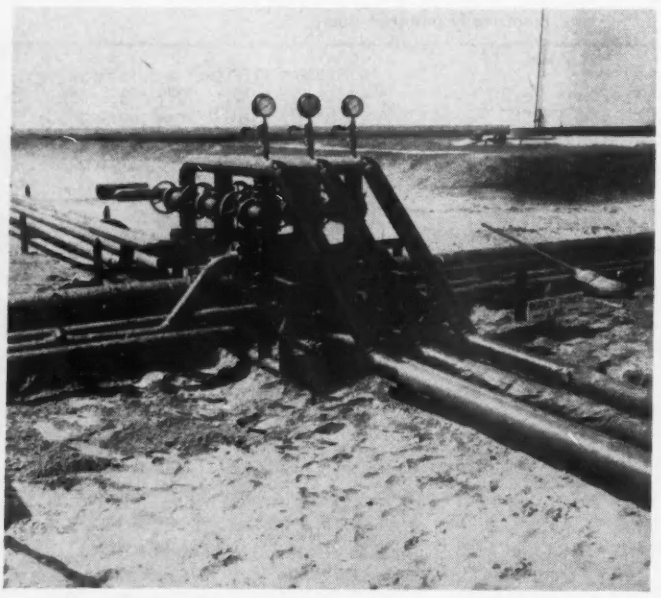
The low-pressure horizontal separator is the heart of the producing equipment on each structure. It is 5 feet in diameter, 20 feet long, has an operating pressure of 125 pounds per square inch, and a volume of approximately 70 barrels. Not only does it serve as an oil and gas separator, but it acts as a surge tank, a test vessel and a free water knockout unit. Inside the vessel are two baffle plates and a gas scrubber. Openings into the unit include an oil and gas inlet, an oil and gas outlet, a free water outlet, a drain hole, a cleanout plate and float outlets for high-level controls, oil-water interface, and dump controls. A bypass line around the baffle plate makes it possible to equalize pressures in the separator so it may be used as a test unit.

Electric controls for the electrically-driven pipe line pump consist of a mercury switch wherein two electrodes are immersed in mercury when the switch is on, or when the circuit is completed. This switch is linked to a fulcrum arm attached to the dump float which extends from one end of the horizontal vessel. Under normal operating conditions, oil flows into the separator where the gas is taken off through a back-pressure valve and flared, since there is no commercial sale for the gas at present. As the oil level in the sump rises, the dump float rises until a predetermined level is reached. At this point, the electrodes are submerged in the mercury and the pump takes oil from the sump and pumps it through the submarine pipe line to the shore terminal. The pump continues to operate until the oil level falls and one electrode in the mercury switch emerges from the mercury and the circuit is broken, thereby stopping the pump.

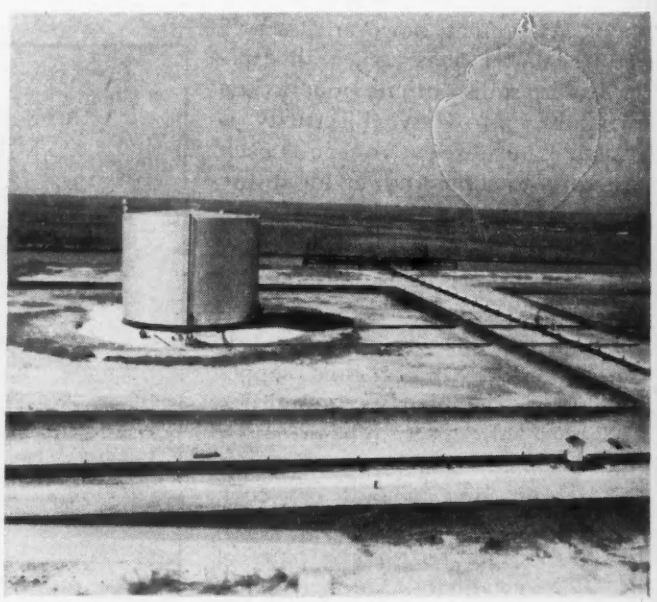
The Test Unit

The test separator is identical in construction to that of the low-pressure bulk unit. It differs in the manner in which it is hooked up into the system. Instead of a high-pressure separator ahead of it to handle production from the higher pressure wells, a back-pressure regulator maintains the pressure within the vessel below operating values. Since this unit is used only periodically for testing the production from each well once a month, it is manually controlled. It has sufficient capacity to put a well on a flow test for two or three hours. A calibrated gauge glass at one end of the unit indicates the actual production of oil and water. Test cocks around the circumference of the separator make it possible to draw off samples when desired.

After a satisfactory test period, flow into the separator is changed into one of the other headers, depending upon the flowing pressure of



Manifold at the terminal by which the flow of oil into the terminal is controlled.



A typical storage tank at Fourchon terminal. Oil loading dock is shown in the background.

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the well. An accurate measurement is made, and the gauger or pumper starts a steam-type reciprocating pump located alongside the electrically-driven pump. The steam pump is powered by gas supplied from the low-pressure separator. Oil is taken from the test unit by the steam pump and pumped through the same submarine pipe line into which the electrically-driven pump discharges.

The test separator has a high-level control float that acts as a safeguard should the gauger fail to return before the vessel fills. This high-level float controls the diaphragm pressure on a three-way valve. When the liquid rises beyond á given level, the back-pressure on the diaphragm is released, causing the fluid to flow into the low-pressure bulk unit, where it is treated along with production from the remaining wells. (Figure 4.)

Safety Measures

There are several practical safety measures which provide a fool-proof system against possible equipment failures. In addition to bottom-hole storm chokes installed in each offshore well, there is a master safety gate valve placed in every christmas tree as shown. This safety valve is of the gate type, the valve stem of which is a connecting rod attached to a piston operating inside a cylinder. The gate can be controlled by manipulating the pressures on either side of the valve stem piston. When the gate is open under normal producing conditions, the pressure on both sides of this piston is equalized. However, when the pressure on the rod-side of the piston is released, the expansion of gas on the opposite side of the valve forces the gate closed and thereby shuts in the well.

A diaphragm valve controls the exhaust of pressure inside the piston when the valve is automatically closed. This diaphragm valve is normally kept closed by gas pressure exerted on top of the diaphragm. Should this pressure be released, the pressure inside the stem end of the piston is bled off, and the master gate valve is closed.

Gas pressure in this pilot line is controlled by a three-way diaphragm valve in the pilot system. So long as pressure exists on top of the diaphragm, the pilot system is pressurized. However, when this pressure is released from the top of the diaphragm, the valve discharges pressure in the pilot system which in turn closes the master gate valves in all wells. The pressure on top of the three-way diaphragm valve is released by two means. A high-level float on the low-pressure bulk unit or a high-level float on the test unit will release this diaphragm pressure in the event fluid rises beyond a predetermined level in either vessel. This high-level control on the test separator is a second safeguard, and is in addition to the float control which transfers the flow of oil from the test separator to the bulk unit. In the event this valve fails, the high-level control will shut in all wells on the platform until the gauger remedies the situation. This safety control system, shown diagrammatically in Figure 4, makes it possible to install high-pressure controls that will also shut in all wells. However, since the high-pressure separator will operate at pressures much higher than that of any producing well, it was not deemed necessary. Each horizontal unit is equipped with this high-pressure control.

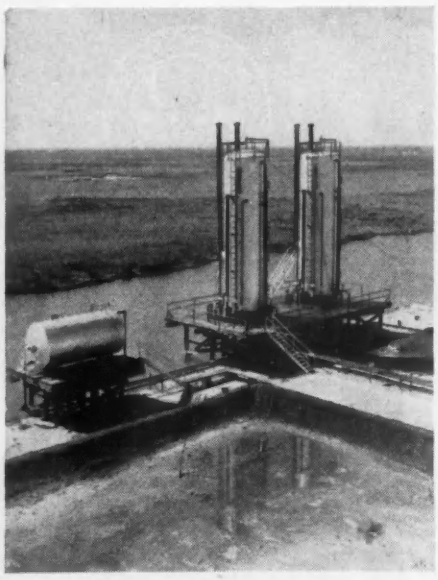
Additional Facilities

A prefabricated steel house has been installed on "D" structure to accommodate about 14 men if necessary. It is equipped with fine sleeping quarters and an excellent galley. Under normal field operating conditions, it is contemplated that only two men and a boat driver will remain on the platform. At present, the housing and cooking facilities serve the roustabout crews working in the field. A 17-inch television set eases the seven-day work period for the two gaugers who then are given seven days off.

At headquarters for the field near Leesville, La., adequate boat docks, warehousing and loading facilities, offices and communications are maintained. Living quarters for operating personnel were built during 1950 and consist of six elevated frame homes.

A Step Ahead

The favorable location of Bay Marchand in regard to distance offshore and to supply points has proven advantageous considering problems confronting other offshore operators. In some instances, fields are located 30 miles from nearest land and 72 miles from supply ports. However, the progress made in proving practical methods for economically handling production from the Bay Marchant field points the way for a solution to similar production problems in other fields.



Heater-treaters at Fourchon terminal, with skimming tank at left.

Bay Marchand field office, communications center and warehouse are alongside one of the two boat slips near the field camp.

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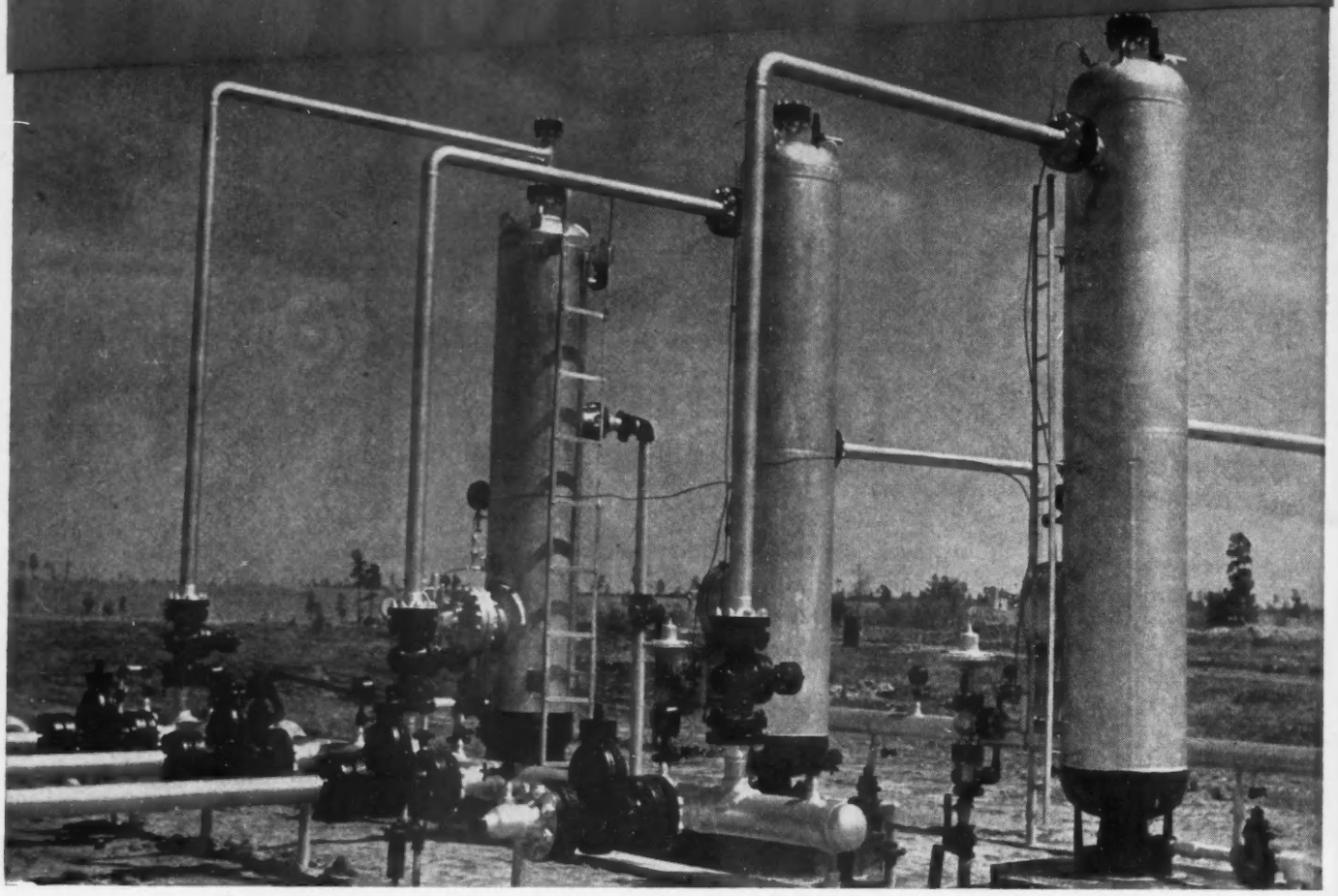
Calculation of Natural Condensate Recovery



By T. W. BRINKLEY and R. C. CURTIS

The Carter Oil Company, Tulsa

TWO METHODS of calculating ultimate condensate recovery by natural pressure depletion of a constant-volume reservoir are presented as an aid in making a careful economic analysis of any projected pressure maintenance program. Condensate recovery is first estimated by utilizing the gas-condensate ratio, while a second method discussed employs sample data in calculating condensate recovery. In addition to these calculations, the authors present a simplified method of estimating condensate recovery, based upon an empirical relationship developed from several reservoir fluids. It should prove helpful in making preliminary analysis.

PRESSURE maintenance of gas-condensate reservoirs has become a widely recognized procedure for increasing ultimate condensate recovery. Since considerable plant investment and operating expenses are usually associated with pressure maintenance, a careful economic analysis of the potential recovery gains is often desirable before a particular project is undertaken.

The techniques for evaluating condensate recovery by cycling procedures have been well covered in the technical literature during the recent years. However, little has been published concerning the calculation of natural condensate recovery, which is necessary for evaluation of pressure maintenance benefits.

Two methods of computing ultimate condensate recovery by natural pressure depletion of a constant-volume reservoir are presented. The recovery can be estimated readily if only the initial produced gas-condensate ratio is known, or may be computed more precisely for an individual condensate-bearing gas. The first method is based on new correlations of reservoir volume factor and recovery percentage with gas-condensate ratio. The second method consists of calculating incremental gas production per unit pressure drop and the condensate recovery per unit volume of gas production, the combination of these two factors to yield the rate of condensate production per unit pressure drop, and finally the summation of the condensate production increments as the cumulative condensate recovery. A simplification of the second method is made possible by a new empirical relationship which supplies the approximate stock tank

condensate recovery when the well stream composition is determined.

The approximate method of computing condensate reserves is based on two empirical relationships developed from actual reservoir fluids, and requires only the original gas-condensate ratio for estimation of ultimate condensate recovery in barrels per barrel of reservoir pore space. The two basic curves are the reservoir volume factor, Figure 1, and the percent recovery of condensate content, Figure 2.

The reservoir volume factor, or barrels of stock tank condensate in place per barrel of reservoir pore space, is related to original gas-condensate ratio in Figure 1. Undersaturated gases have higher condensate contents per reservoir barrel, when referred to gas-condensate ratio, than do saturated gases, so the average trend in Figure 1 is drawn slightly higher at higher gas-condensate ratios than the majority of data, which generally represent special laboratory saturated gases in this region. In using Figure 1, the lower trend of data should be used if the gas is definitely saturated; the average curve should be used if saturation of the gas has not been established. The reservoir volume factor versus gas-oil ratio of reservoir oils has ben included in Figure 1 to demonstrate that there is a consistent relationship for all magnitudes of gas-oil ratio and gas-condensate ratio.

The approximate percent recovery of stock tank condensate also seems to be related to original gas-condensate ratio, as illustrated in Figure 2. The stock tank condensate recovery curve is guided by a similar and related trend with more plentiful data, the recovery of "pentanes plus" from the reservoir by pressure depletion to 500 pounds per square inch absolute.

The approximate condensate recovery by natural pressure depletion is computed by multiplication of the proper values from these two curves, yielding ultimate barrels of stock tank condensate per barrel of reservoir space. For example, if the gas-condensate ratio of a new reservoir was measured at 20,000 cubic feet of gas per barrel of stock tank condensate through conventional field stage separation, the original condensate content is estimated at 0.08 barrels per barrel of reservoir space from Figure 1 and the natural recovery at 57 percent from Figure 2. In volume, natural ultimate condensate recovery is thus estimated at $(0.08) \times (0.57)$ or 0.0456 barrels per barrel of reservoir space. In barrels per acre-foot, natural ultimate recovery is:

$$7758 \times \frac{\text{(Porosity Percent)}}{100} \times \frac{\text{(100-Connate Water Percent)}}{100} \times \frac{\text{(Recovery Percent)}}{100} \times \text{(Reservoir Volume Factor)}$$

For an assumed case of 20 percent porosity and 10 percent connate water, the ultimate natural condensate recovery for the reservoir with an original gas-condensate ratio of 20,000 cubic feet per barrel would be:

$7758 \times (0.2) \times (0.9) \times (0.57) \times (0.08) =$ 63.67 barrels per acre-foot

Accompanying ultimate gas production may also be roughly approximated by:

$$\frac{\text{Original GOR}}{\text{Recovery Percent}/100} \times \text{(Condensate recovery in barrels per acre-foot)},$$

or in the assumed case:

$(20{,}000/0.57) \times (63.67) = 2.2$ Mmcf per acre foot.

Calculated Condensate Recovery From Sample Data

While the approximate method is useful for preliminary recovery estimates, a more precise calculation is warranted for reservoirs of considerable magnitude. Accurate sampling and laboratory analysis of the well stream fluids is required to establish the physical characteristics of the reservoir fluids, which is the condensate-bearing gas. Essential laboratory data

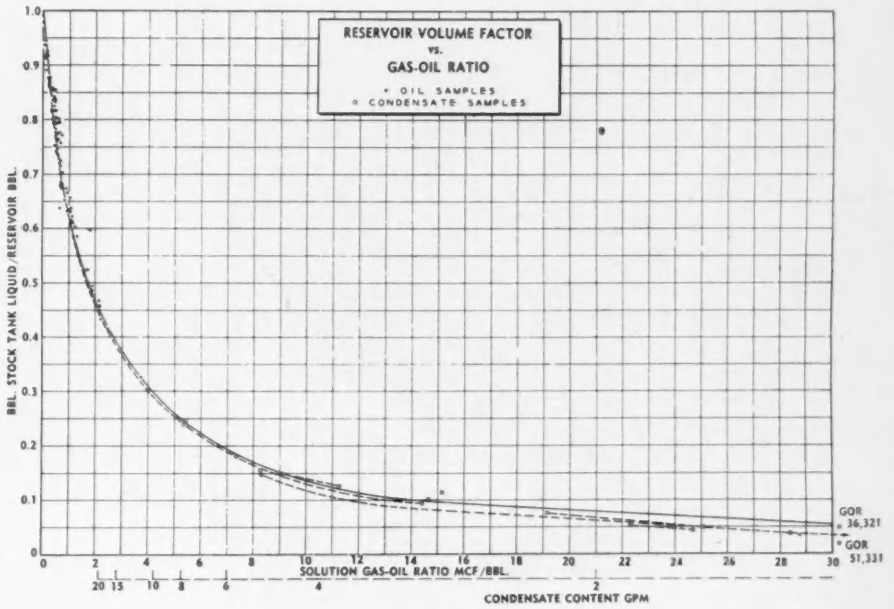


FIGURE 1

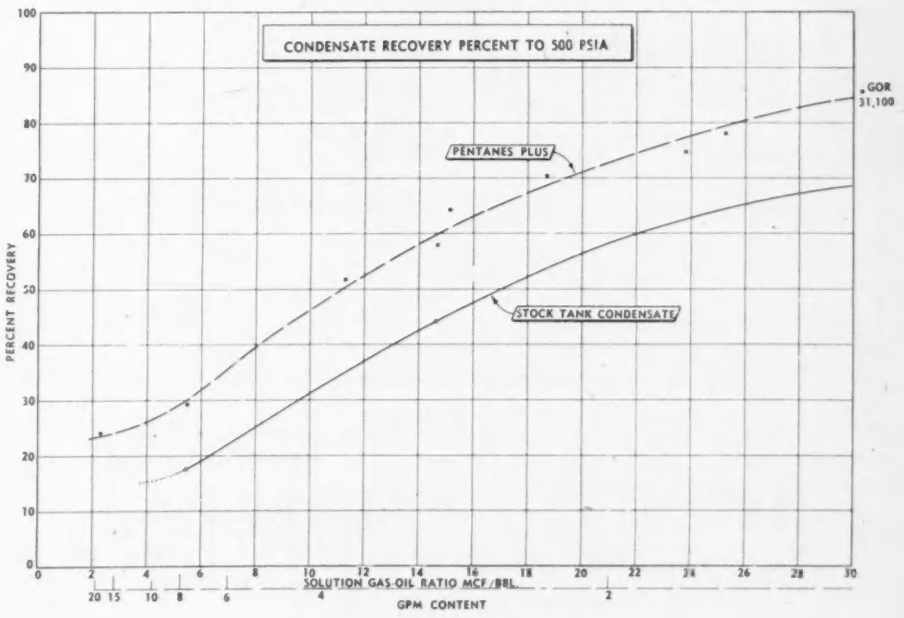


FIGURE 2

include the composition and specific volume of the original reservoir gas and the pressure-volume relationship of the reservoir gas.

The recovery estimates are expedited and also are more accurate if laboratory analysis includes differential condensation at reservoir temperature of three samples of original reservoir gas from the dew point pressure down to pressures of 75, 50, and 25 percent, respectively, of the dew point pressure. Each of these samples, as well as a sample of the original reservoir gas, is then flashed through small scale separators which are maintained at the actual pressure and temperature of the separators in the field. This latter laboratory work establishes the variation of condensate recovery per barrel of reservoir voidage throughout the pressure depletion of the reservoir.

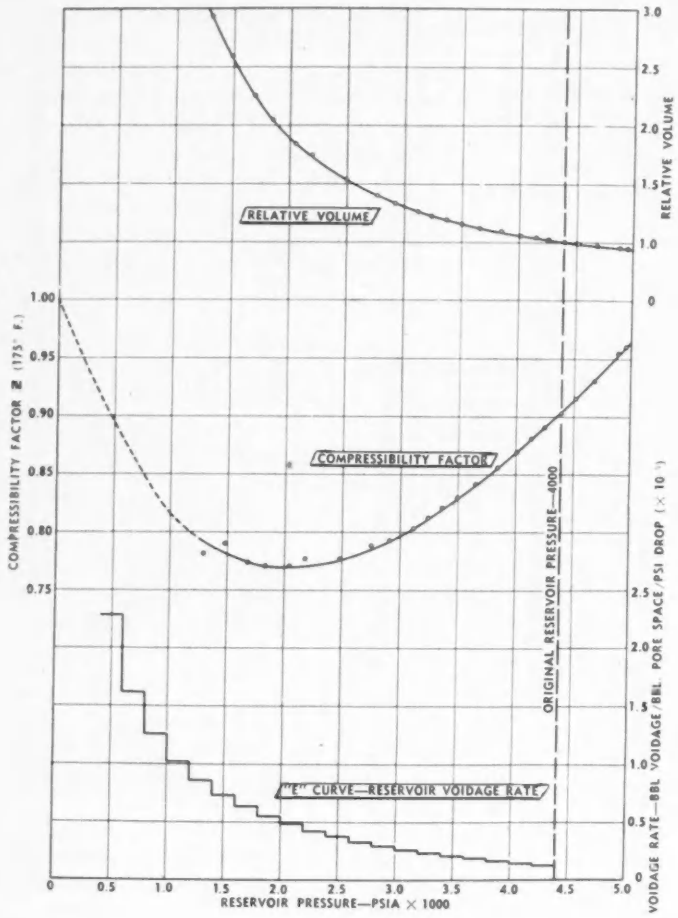


FIGURE 3

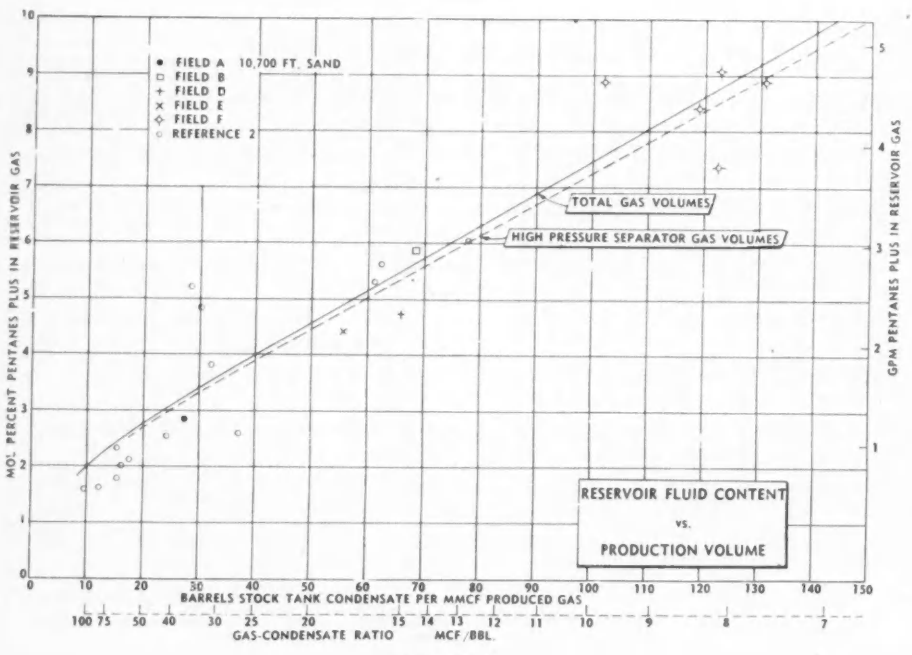


FIGURE 4

The cumulative natural condensate recovery to any desired abandonment pressure is computed in three steps. First, the rate of well stream production, or reservoir voidage, per unit pressure drop from one barrel of pore space is calculated. In a constant volume reservoir, natural pressure depletion by withdrawals is determined solely by the PV relationship. Second, the stock tank condensate recovery per barrel of reservoir voidage is determined. This condensate recovery value varies with the stage of depletion because of changes in the density and composition of the well stream as the pressure declines. It may be determined at intervals of pressure depletion in the laboratory or solved with phase calculations. The third step is the calculation of the rate of stock tank condensate recovery per barrel of pore space per pound per square inch pressure drop by multiplication of the two preceding factors, and the accumulation of this third factor to yield the total condensate recovery to the abandonment pressure.

Reservoir Voidage Rate

At the original reservoir pressure, one barrel of reservoir pore space contains one barrel of reservoir gas. Expansion of this amount of gas yields a PV relationship similar to the data for Field "A," the East Lindsay Bromide Pool, in Figure 3. However, in a constant volume reservoir each increment of volume expansion is removed from the reservoir as well stream production, so the mass of remainging reservoir gas continuously diminishes with decline of pressure, and amounts to $\frac{1}{Vp}$ fraction of the original mass of reservoir gas at any pressure, p. A detailed sample calculation of this method was previously published.[1]

The rate of reservoir voidage, or well stream production, can be calculated from the PV relationship as barrels of reservoir voidage per barrel of pore space per pound pressure drop by:

$$E_{(1-2)} = \frac{1}{V_{p_{avg}}} \times \frac{V_{p_1} - V_{p_2}}{P_1 - P_2} \qquad (1)$$

The condensate recovery per barrel of reservoir voidage =

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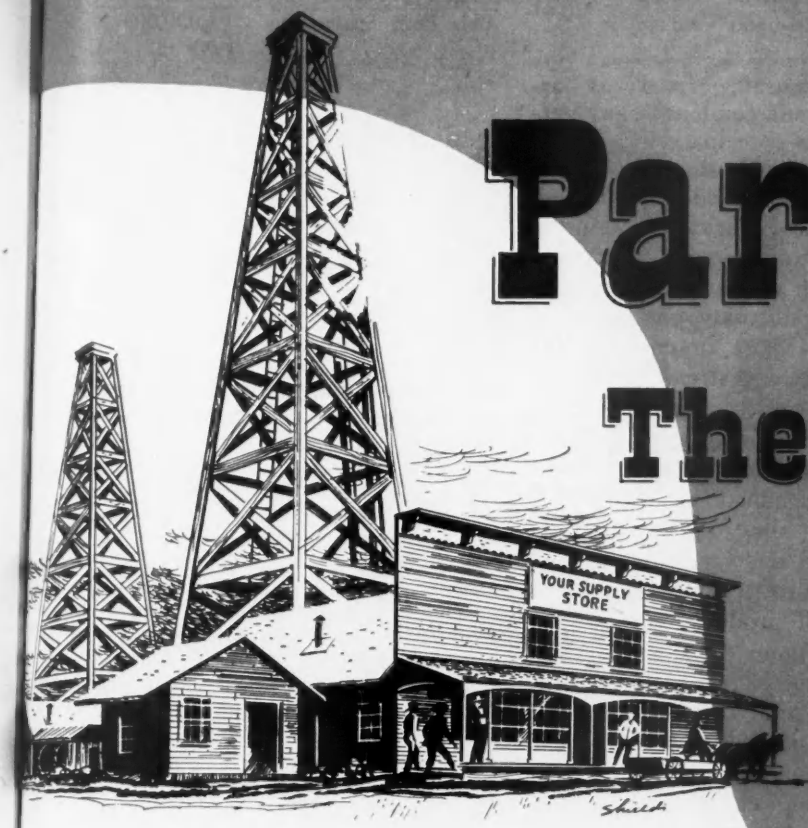

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Barrels condensate/mol condensate are calculated by multiplying the mol composition of the stock tank condensate by barrels/mol constant for each of the individual components. The mols condensate/mol of reservoir voidage is determined by phase calculations by staging one mol of well stream or reservoir voidage through appropriate separators and stock tank, and mols of reservoir voidage per barrel of reservoir voidage is determined from $PV(5.61) = ZnRT$.

As previously mentioned, the condensate recovery per barrels of reservoir voidage can be experimentally established in the laboratory for several stages of pressure depletion. These values are then graphically plotted against corresponding values of reservoir pressure and a curve drawn to permit interpolation at any desired pressure.

The rate of stock tank condensate recovery per pound per square inch pressure drop is determined by the multiplication of the two preceding steps:

$$\frac{\text{Bbl. Condensate}}{\text{Bbl. Reservoir Voidage}} \times \frac{\text{Bbl. Reservoir Voidage}}{\text{Bbl. Pore Space/psi Drop}} \quad (3)$$

The total condensate recovery for the incremental pressure drop $P_1 - P_2 =$

$$\frac{\text{Bbl. Condensate}}{\text{Bbl. Pore Space/psi}} \times (P_1 - P_2) \quad (4)$$

Incremental condensate recovery is calculated in this fashion from original to abandonment pressure, and the increments summed to yield the ultimate condensate recovery as barrels of stock tank condensate per barrel of reservoir pore space.

This method is a simplification of the preceding detailed solution and is based on an empirical relationship developed from several reservoir fluids[1,2] which shows the recovery of stock tank condensate per Mmcf of produced gas as a function of the composition of well stream fluid, Figure 4.

Well stream fluid composition variations with reservoir pressure decline may be determined by differential liberation of the original reservoir gas, and then the approximate stock tank condensate recovery in barrels per Mmcf of produced gas can be read from Figure 4 for each incremental pressure drop from original reservoir pressure to abandonment pressure. In the pressure increment 3600-3400 psia in Field "A," the "pentanes-plus" content of the well stream gas was determined as 5.29 mol percent by laboratory differential analysis, so from Figure 4, the approximate stock tank condensate recovery is 62 barrels Mmcf in that pressure interval.

The rate of gas production, Mmcf produced gas per barrel pore space per psi pressure drop, is then computed from the "E" value of Equation 1:

$$\frac{\text{MMCF produced gas}}{\text{Bbl. Pore Space/psi}} = \frac{5.61}{1{,}000{,}000} \times E_{(1-2)} \times \frac{520}{T} \times \frac{Pavg}{14.7} \times \frac{1}{Zavg} \quad (5)$$

In the pressure increment 3600-3400 psi for Field "A," the rate of gas production is:

$$5.61 \times 10^{-6} \times (0.20631 \times 10^{-3}) \times \frac{520}{635} \times \frac{3500}{14.7} \times \frac{1}{0.83} \text{ or,}$$

0.272×10^{-6} MMCF/bbl. pore space/psi

And the approximate rate of stock tank condensate recovery in barrels per barrel reservoir pore space per psi drop is:

$$\frac{\text{Bbl. Stock Tank Condensate}}{\text{MMCF Produced Gas}} \times \frac{\text{MMCF Produced Gas}}{\text{Bbl. Pore Space/psi}} = \quad (6)$$

$$(62) \times (0.272 \times 10^{-6}) =$$

16.864×10^{-6} Bbl. Stock Tank Condensate/bbl. Pore Space/psi.

Total condensate recovery per barrel of pore space for the 200 psi pressure increment from 3600-3400 psia is:

$$\frac{\text{Bbl. Stock Tank Condensate}}{\text{Bbl. Pore Space/psi}} \times (P_1 - P_2) = \quad (7)$$

$$(16.864 \times 10^{-6}) \times (200) =$$

3.37×10^{-3} Bbl. Stock Tank Condensate/bbl. Pore Space.

In Field "A," the cumulative condensate recovery by this method, using mol percent content in pentanes-plus of reservoir fluid stream, was 18.4 percent of the original stock tank condensate content as compared to the calculated recovery of 17.6 percent from sample data.

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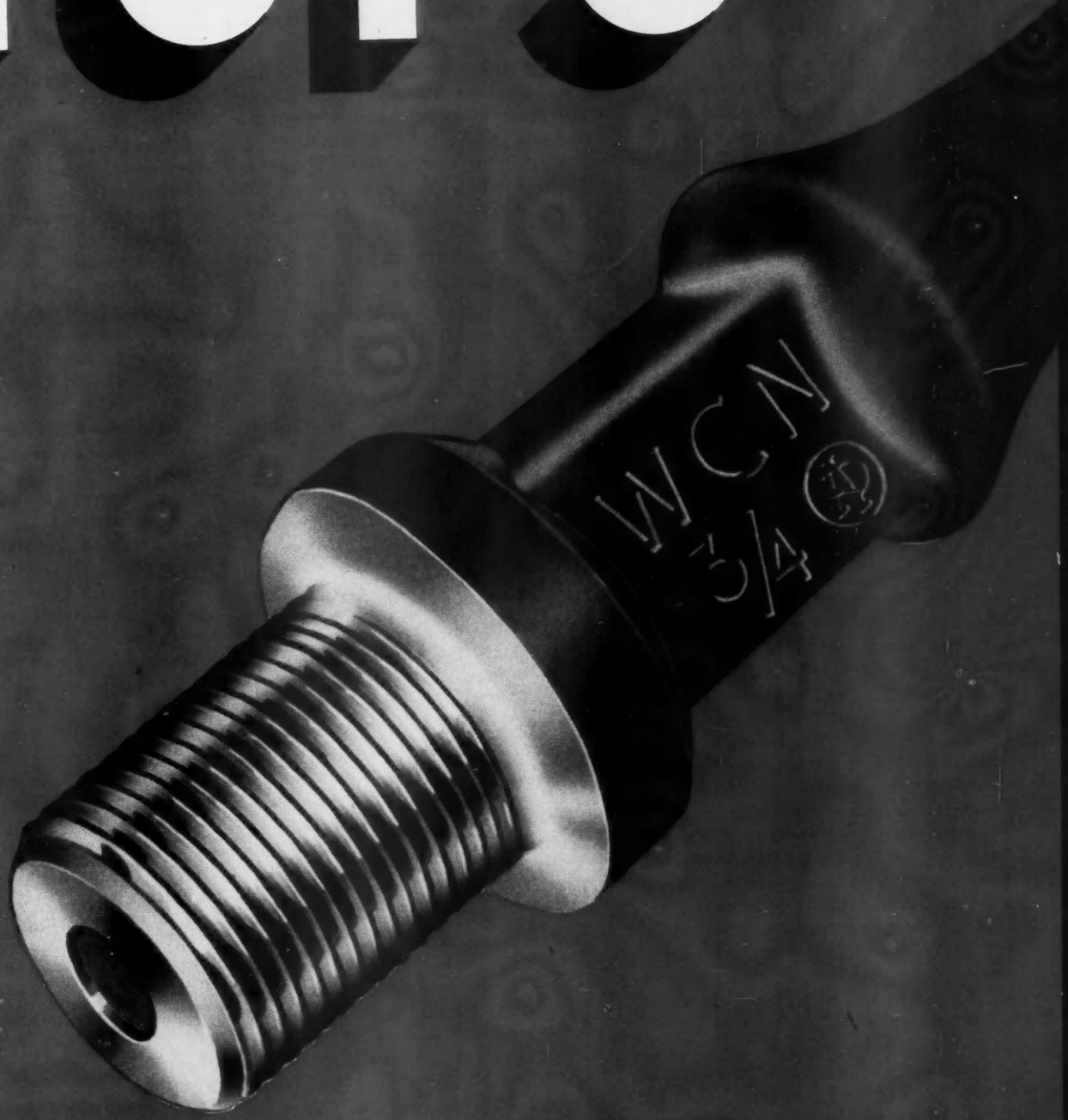
About the Authors

R. C. CURTIS is chief division engineer for The Carter Oil Company at Oklahoma City. After graduation from Texas A. & M. College with a B.S. degree in chemical engineering in 1937, he was employed by Carter as a student engineer. In 1939 he became a junior petroleum engineer. Curtis entered the armed forces in 1942 where he served as a first lieutenant in the Army Air Corps. He returned to Carter in 1945, and was promoted to assistant division engineer at Oklahoma City in 1947. In June, 1948, he was appointed to his present post.

THOMAS BRINKLEY has been closely associated with petroleum production operations since his graduation in 1940 from the University of Tulsa, where he received a B.S. degree in petroleum production engineering. During World War II he served as platoon commander with the 35th Infantry Division, and later assisted SHAEF G-4 section on inspections of oil fields near Hannover, Germany. In 1946 Brinkley joined The Carter Oil Company and until February, 1951, was located in Oklahoma City as division reservoir engineer. Brinkley is now in Tulsa as reservoir engineer for Carter.

TOPS



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A Review of

Reservoir Engineering

Part 2—Conclusion

By NORMAN J. CLARK

Petroleum Engineer,
Humble Oil & Refining Company, Houston

Gas Cap Drive Reservoirs

The gas cap drive reservoir is a reservoir having a gas cap but no water leg and which operates under the influence of the expanding gas cap. A gas cap drive reservoir is characterized by a gradual but essentially continuous pressure decline and with continuing increase in reservoir gas-oil ratios as shown by Figures 2 and 3, respectively. Pressure and gas-oil ratio trends are influenced by permeability of the reservoir, the size of the gas cap, and the degree of conservation of gas cap gas. By conservation of gas is meant the degree to which production of gas cap gas is minimized. Recovery from gas cap drive reservoirs ranges from 30 to 80 percent of original oil in place, depending upon the size of the gas cap, whether gas cap gas moves through all segments of the reservoir sand and all areas over which the reservoir occurs, and the degree to which gravitational segregation is occurring within the reservoir. The effects of gravity will be discussed more in detail later.

Analysis of the gas cap drive reservoir depends upon two types of calculations. They are the volumetric behavior and displacement efficiency calculations. The principal differences between the method of analyzing the gas cap drive reservoir and the water drive reservoir are that the volumetric balance is utilized solely to determine volumetric behavior, there being no water influx calculations involved in the gas cap drive reservoir, and the displacement calculations concern gas displacement of oil instead of water displacement of oil.

Volumetric behavior of the gas cap drive reservoir is analyzed by means of the same type volumetric balance equation as used in water drive with some modifications involving gas relative permeabilities usually needed to apply to the conditions of the gas cap drive reservoir. The volumetric balance here balances oil and gas from the oil zone and gas from the gas cap, as withdrawals, against oil and gas expansion in the oil zone together with gas cap change, as materials taking the place of the withdrawals. Figure 8 illustrates this volumetric balance relation. Again, as in the case of water drive reservoirs, the volumetric behavior computations analyze the volume changes. Further analysis utilizing displacement calculations under different modes of operations is necessary to determine changes in the fluid distribution in the reservoir from which ultimate recovery from the reservoir under the different modes of operations can be calculated. Figure 9 illustrates schematically the mechanism of oil displacement by gas cap expansion. The nature of gas displacement and the appropriate calculations are very similar to those dealing with water displacement and of particular importance is the quantity of oil remaining behind the displacing gas from the gas cap which is in inverse proportion to the amount of oil displaced by the gas.

About the Author

NORMAN J. CLARK, is a senior engineer in the Reservoir Engineering Section of Humble Oil & Refining Company's Petroleum Engineering Division in Houston. His primary job is that of training reservoir engineers. Clark received his B.S. degree in mathematics and physics from Southwest State Teachers College in 1937. After a year of teaching high school mathematics and a year with Barnsdall Pipe Line Company in Victoria, Texas, he entered the University of Oklahoma in 1939 and received his B.S. degree in petroleum engineering in 1941. Beginning as a roustabout for Humble in the Kelsey district of Southwest Texas, he has served in many capacities since, except for 3½ years spent in the Bureau of Ordnance of the Navy where he worked on the design and development of aircraft bombing equipment.

Combination Drive Reservoirs

The most common type of reservoir is one which operates under the influence to some degree of both water and gas encroachment and is called combination drive. It might be added that dissolved gas drive generally influences production in reservoirs as liberation and expansion of some dissolved gas usually occur with pressure drop. Reservoir pressure and gas-oil ratio trends in a combination drive reservoir depend upon all the factors involved in all the pure drive reservoirs mentioned above, which are permeability of the reservoir, size of the gas cap, availability of water, rate of production, and conservation of both gas and water.

A study of a combination drive reservoir presents more complications than the other drives mentioned; however, there are only two phases of the study. These are the volumetric behavior and displacement efficiency computations. The volumetric behavior phase employs the volumetric balance and unsteady state radial flow equations from which gas cap change, water influx, and pressure trends are determined. The volumetric balance here balances the produced oil, gas, and water, as materials withdrawn, against oil and gas expansions in the oil zone together with gas cap change and water influx into the reservoir, as materials taking the place of the withdrawals. Figure 10 illustrates this volumetric valance relation. Here again the computations deal

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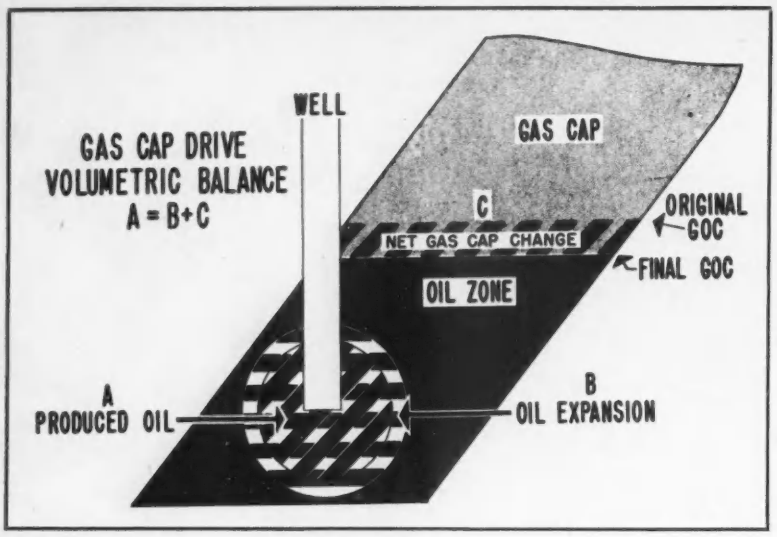

FIGURE 8. Gas cap drive reservoir illustrating volumetric balance method of calculating behavior.

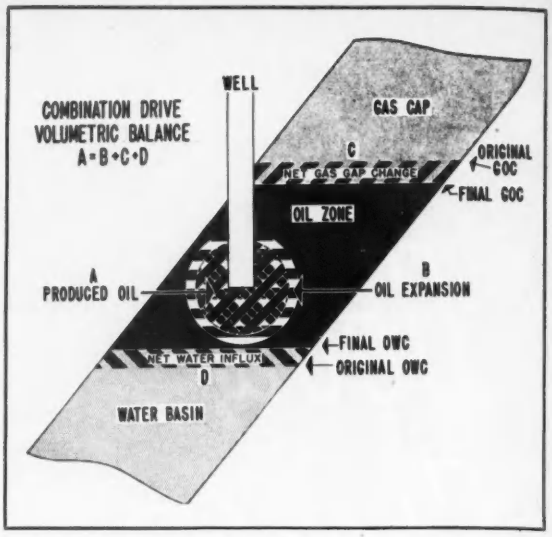

FIGURE 10. Combination drive reservoir illustrating volumetric balance method of calculating behavior.

only with volumes, and to obtain further information regarding the location and distribution of fluid saturations, the displacement studies and displacement efficiency calculations are utilized. In combination drive, however, the displacement calculations involve the volumes of both the gas cap encroachment and water influx into the reservoir.

Gravitational Segregation

Gravitational segregation or gravity drainage may be placed in a class by itself as a driving mechanism; however, it is considered rather as a part of all types of drives which tend to modify them. Gravitational segregation is the tendency due to the forces of gravity for gas, oil, and water to return to a distribution in the reservoir according to their densities after the reservoir has been produced and equilibrium conditions in the reservoir become disturbed. Gravity drainage can play a great part in recovery of oil from a reservoir, for example, if conditions are suitable, recovery from some dissolved gas drive reservoirs may be increased to that of good water drive reservoirs by gravity drainage. Other reservoirs may, by proper control of producing rates, have their gravity drainage effects augmented to a definite advantage in the form of additional oil recovery. Figure 11 illustrates the relative movement of gas to oil in the reservoir at different times by gravitational segregation under reservoir conditions of nonproduction following periods of production. Figure 12 illustrates that at a given time the relative movement of gas to oil at various points in the reservoir is approximately the same, although within a certain radius of the well depending upon the rate of production both gas and oil are moving toward the well because of the high pressure gradients existing near the well. The rate of production can therefore be so high that this radius of influence of the well becomes so great that good effects from gravitational segregation are not obtained for the reservoir as a whole. Good effects from gravitational segregation are therefore obtained by suppressing pressure gradients in the reservoir by the proper adjustment of rates of production.

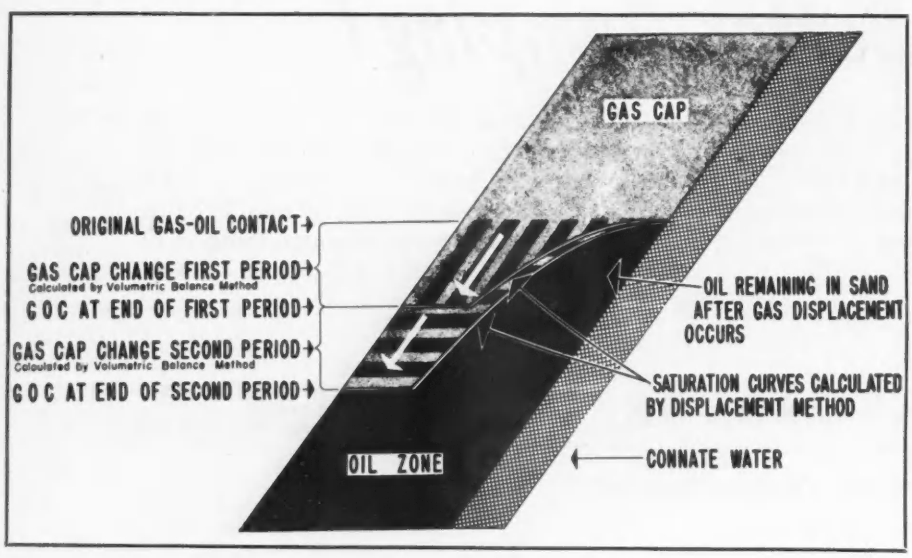
GAS CAP
ORIGINAL GAS-OIL CONTACT
GAS CAP CHANGE FIRST PERIOD
Calculated by Volumetric Balance Method
GOC AT END OF FIRST PERIOD
GAS CAP CHANGE SECOND PERIOD
Calculated by Volumetric Balance Method
GOC AT END OF SECOND PERIOD
OIL REMAINING IN SAND AFTER GAS DISPLACEMENT OCCURS
SATURATION CURVES CALCULATED BY DISPLACEMENT METHOD
OIL ZONE
CONNATE WATER

FIGURE 9. Displacement of oil by gas, illustrating method of calculating recovery.

Phase Behavior of Oil Reservoirs

The foregoing volumetric behavior and displacement efficiency discussions concern the changes in volumes of fluid in the reservoir and their re-distribution in the reservoir. Being able to predict these changes is, of course, of major importance but it is only part of the story. During the various phases of the journey of the hydrocarbon materials from the pores in which they are found to their ultimate goal in the consumers' market, they undergo substantial change. The reservoir fluid separates into two portions: liquid crude and natural gas. Different operating conditions at the separators result in different quantities of crude and gas being produced from a given volume of oil in the ground. The behavior of the oil and gas as the conditions of temperature and pressure change is called phase behavior, and it is of major importance to control this behavior both in the reservoir and at the surface in order to obtain a maximum recovery of the more valuable products as a result of the production operations. Figure 13 illustrates a typical but more important problem falling in this category, that being the determination of the conditions of surface separation which will yield the greatest amount of stock-tank oil from a given amount

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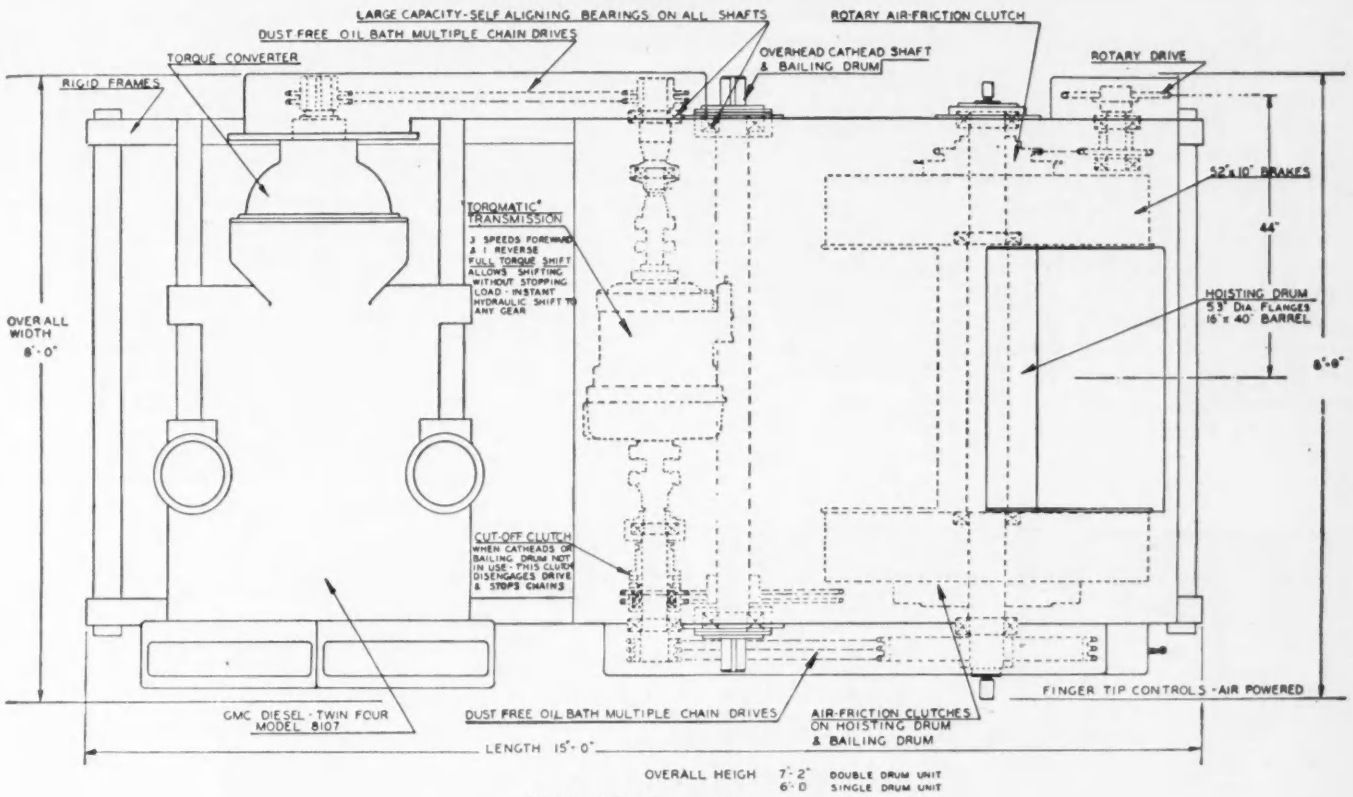
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2	FPM	0	87	174	260	347	434	521	608	694
	PULL	34,400	26,680	21,060	16,500	12,990	10,820	9 360	8,190	7,140
3	FPM	0	202	404	606	809	1,011	1,213	1,415	1,618
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of reservoir oil. Mathematical relations were published by Buckley[8] whereby the phase behavior of reservoir oil may be calculated. These calculations are termed flash calculations or equilibrium calculations.

Gas Condensate Reservoirs

Completing the types of reservoirs for discussion is a separate and distinct type, the gas condensate reservoir, which under original conditions has only a gas in place in contrast to those oil producing reservoirs having gas and oil or oil only. This type reservoir may or may not have a water leg and therefore may or may not have a water drive. Figure 14 illustrates a typical problem concerning the gas condensate reservoir, that being the determination of a separator pressure which will yield the greatest amount of liquid condensate from a given amount of reservoir gas.

As pressure drops in a gas condenstate reservoir, a liquid condenses out of the gas in the reservoir as shown in Figure 15. Thus the problem here is to prevent condensation within the reservoir and to recover a maximum economic amount of salable products from the reservoir. The phase behavior relationships are employed to determine the quantities of condensable hydrocarbons present at various conditions of pressure and temperature. These relationships are utilized to study the hydrocarbon behavior in the reservoir in order to determine the amounts of liquid and gas that are recoverable under various modes of operation. The condensate reservoir may be produced by straight production, with or without a gasoline plant, or cycling at either high or low reservoir pressures. Under any of these various methods of operation, the presence and magnitude of a water drive must be considered if reliable comparisons are to be obtained.

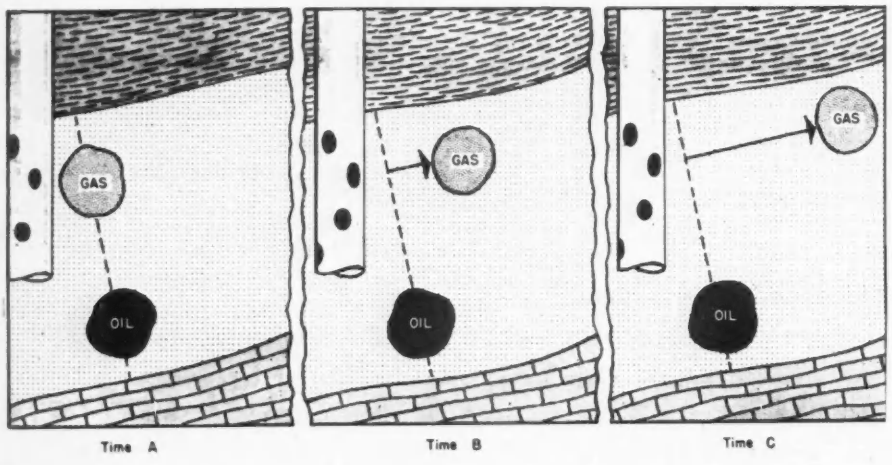

FIGURE 11. Gravitational segregation showing relative movement of gas and oil along the structure at various times during non-producing periods.

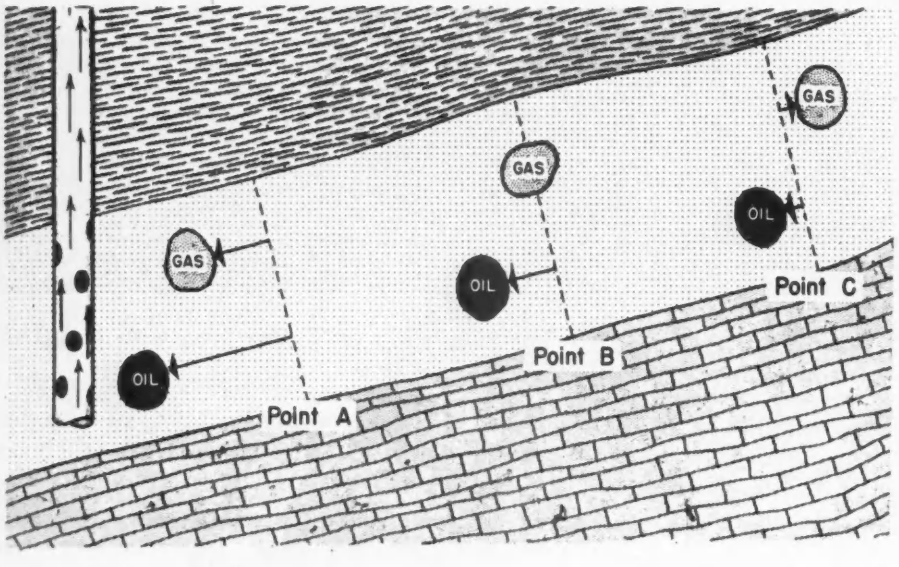

FIGURE 12. Gravitational segregation showing relative movement of gas and oil along the structure at various distances from a producing well.

Verification and Interpretation Of Reservoir Analyses

Perhaps the most important phase of any reservoir analysis is its verification. This phase involves that work devoted to satisfying the analyst himself, as well as others, that the analysis properly reflects the actual changes in fluid volumes in the reservoir. This is particularly true because desired changes in operating programs frequently involve large capital investments which have only negligible salvage value. Thus, an erroneous reservoir analysis could result in a large capital loss even though the misinterpretation of actual reservoir behavior was recognized only a few years after completion of the initial analysis. In addition, recommendations based on a nonrepresentative analysis could result in adoption of an operating program which would reduce rather than improve the efficiency of reservoir behavior. In essence, therefore, the analyst must know the limitations and uncertainties in the complete study and must, insofar as possible, not only determine the effect of these limitations on the final results but also by comparing the results of the analysis with available physical information, attempt firmly to establish a reliable evaluation of the reservoir.

Comparisons which can be made to establish the reliability of the reservoir analysis are both regional and local in nature. Regional comparisons are made merely to determine if the reservoir performs in accord with the performance of other reservoirs in the general area and in accord with the general geological features known to exist in the adjacent area. Local comparisons concern the individual well performance and involve such things as checking movements of the gas cap and water zone to ascertain the validity of a calculated gas cap expansion or shrinkage and water influx.

As it is the vocation of the reservoir engineer to determine reservoir performance, recovery, and behavior under various operating plans designed to augment that recovery, he must also reduce the results of the analyses to a series of operational recommendations for presentation to management. This phase of reservoir engineering may be referred to as the interpretation of the reservoir analysis and covers many major considerations, a few of which are as follows:

- The determination of the maximum efficient rate of production.
- Evaluating the economic payout of such operations as pressure maintenance by water or gas and of secondary recovery programs.
- Evaluating the economics of im-

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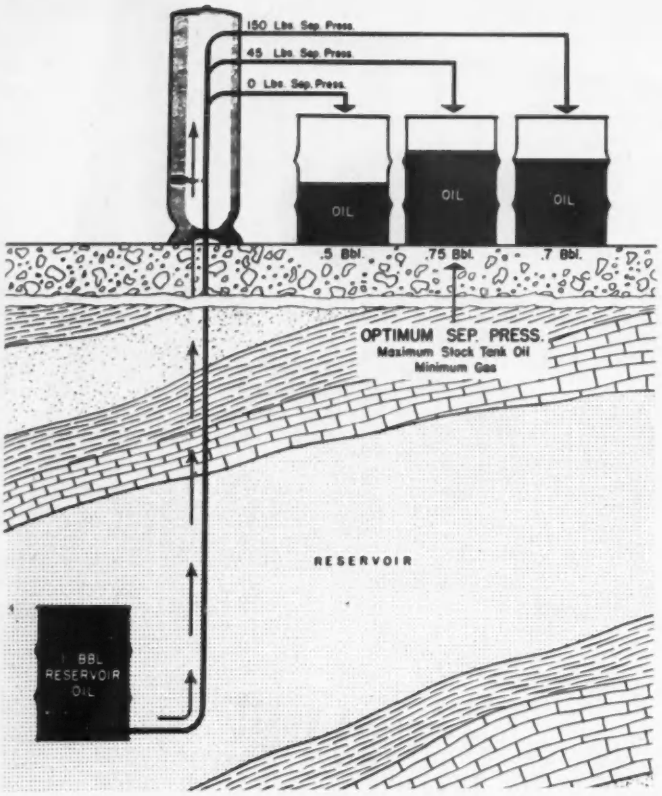

FIGURE 13. Oil phase behavior showing recoveries at different separator pressures.

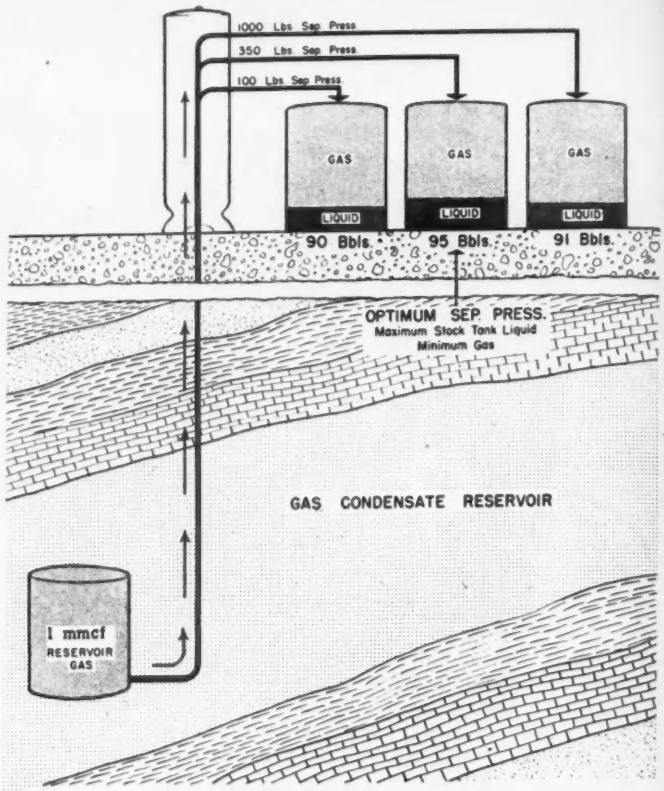

FIGURE 14. Gas condensate phase behavior showing liquid recoveries at different separator pressures.

posing controls on production designed to obtain maximum recovery.

- Planning and evaluating workover programs.
- Planning and evaluating artificial lift programs.

It will be noted that in the abovementioned considerations emanating from reservoir analyses, economics play a great part in the final recommendations. Unlike some other business enterprises the petroleum industry is concerned with utilization of depletable natural resources (oil and gas reservoirs) which are both difficult and expensive to find and develop. The reservoir engineer must therefore investigate, along with the reservoir performance and means for improving that performance, such economic considerations as capital investments, ultimate profits, the period required to return the money, annual income, etc. The economic analysis is as much a part of the reservoir study as the performance calculations and merits the same careful work as all phases of the complete reservoir study, as it is this phase of work that always comes to management for action.

In addition to the economic considerations, the reservoir analyst must keep abreast of the legal aspects of controlling production operations, either primary, auxiliary, or secondary recovery operations, in order to understand the laws governing the production of our natural resources and to understand the regulations set up by the various regulatory bodies constituted to govern the industry. Knowing these legal limitations will permit the analyst to refrain from spending a disproportionate amount of time on analyses of operations which may not be given favor by the regulatory bodies and courts.

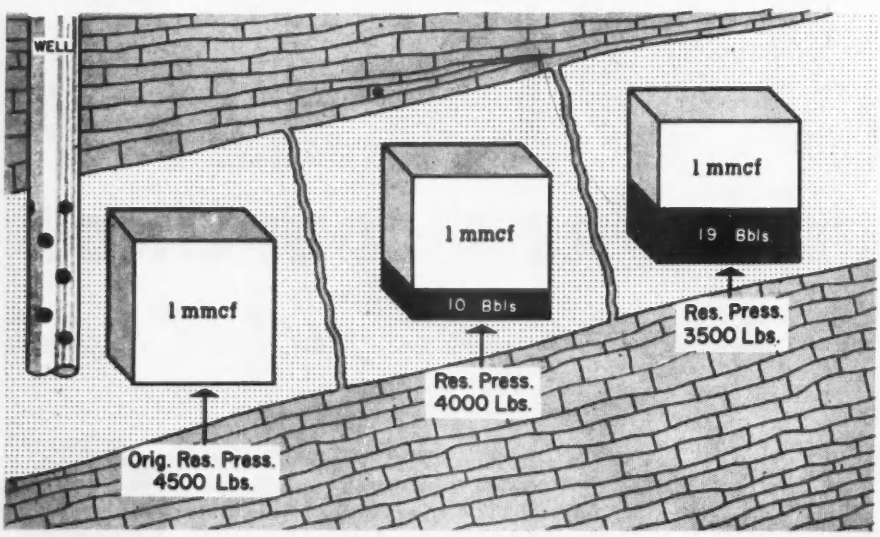

FIGURE 15. Gas-condensate reservoir showing condensation of liquid in reservoir by pressure drop.

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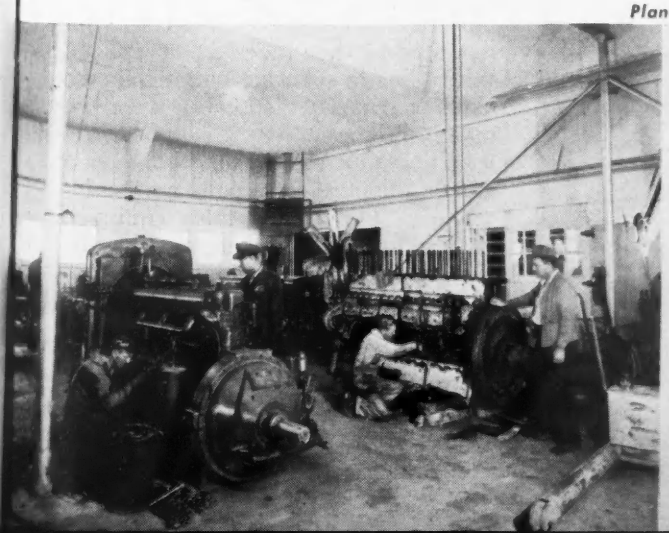

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Trailer-Mounted Power Pump Has Varied Oil Field Uses

A COMPLETE assembly of a high-pressure pipe line pump driven by a multicylinder gas engine, and especially adapted for trailer mounting, has proven valuable in the field. This unit contains several features which further enhance its value as a service pump, and reduces the time and equipment required to transport crude or other liquids.

The trailer-mounted power pump is compact in layout, requiring a minimum of space, and can be placed in a limited area for operation. In isolated areas, it can be connected to tanks or pipe lines so that any commodity can be transferred or disposed of without the need of permanent, expensive installations. Connections and a unitized manifold are attached to the pump suction and discharge so that circulation can be maintained for most situations found around a lease or tank battery. Liquids can be pumped from one tank to another, or from tank to a pipe line, from sumps into treating tanks, or handling water for disposal systems.

Frame of the trailer is similar to a low-bed truck trailer so that equipment can be operated and serviced by pumpers and mechanics without requiring stepladders or improvised high-level platforms. The pump is mounted so that its frame is parallel to the horizontal members of the trailer frame, and the driving engine is at right angles to the centerline of the trailer. The driving pulley is connected to the pump pulley by roller chains operating inside a dust-proof, oil-tight cover guard. The engine is equipped with a fluid clutch that absorbs most of the shock arising from pump pulsations on the double-acting, twin-cylinder reciprocating pump.

Left side of trailer-mounted power-driven pump showing chain guard cover and fluid clutch on natural gas engine.

Right side of portable pump unit shows how flexible fuel hose may be connected to nearest fuel outlet.

The suction line is a long, flexible high-pressure, neoprene rubber hose fitted with quick-connecting unions so that several lengths can be added if necessary. The discharge from the pump is a flexible steel hose containing a number of lubricated swivel joints which make it possible to connect up to tanks or pipe line taps no matter what the angle of approach may be. A pressure relief valve in the discharge line serves as a safety precaution in case the line is blocked or a distant valve closed by mistake during the pumping operation. The manifold is equipped with the necessary valves and pressure gauges to completely control the operation.

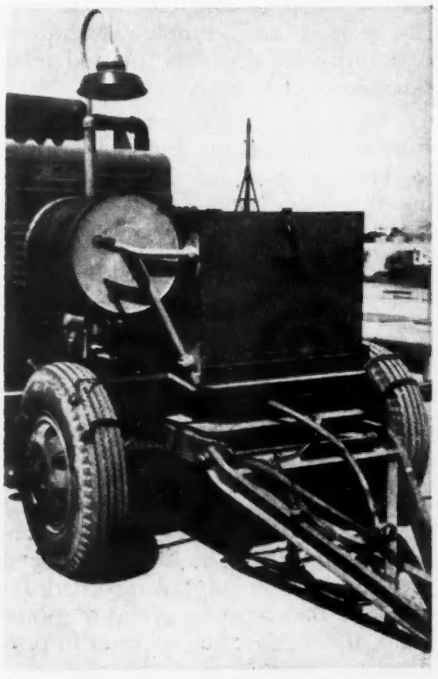
A bucket-type metal seat is near the pump where all controls are located. From this vantage point, the operator seated at the controls can manipulate the pump for pressures and volumes required by bypassing the liquid and by controlling the speed of the pump.

Exhaust gases are disposed of through a conventional muffler mounted across the driving end of the engine in such a manner that the exhaust is discharged away from the operator. The muffler is supported by a vertical pipe so that the engine hood can be removed for repairs and maintenance. The unit is also equipped with a fire extinguisher to fight any local fire that might endanger the operation.

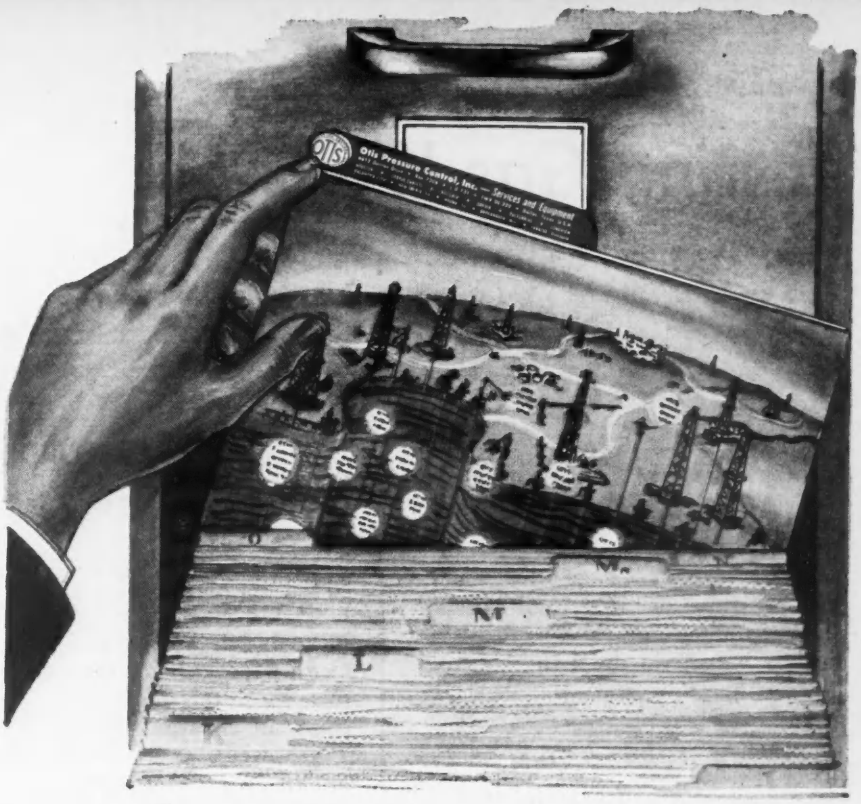
The portable engine-driven pump is fueled with natural gas but can be converted to gasoline. Gas is supplied

through a long, neoprene, high-pressure rubber hose reeled on a drum mounted on one side of the tool box placed on the front of the trailer as shown. The drum is attached to the tool box with three-fourths-inch pipe containing unions in all four supporting brackets, making it possible to remove the entire assembly without having to use an acetylene cutting torch. The reel contains from 150 to 200 feet of one-inch hose which simplifies hooking up to a gas connection at some point on the lease or near the tank battery. This length of hose places the internal combustion engine beyond the danger point at the tank battery or workover rig where it may be required for some special job.

The unit is electrically wired with vapor-tight conduit and fittings as an added safety measure in providing illumination for the surrounding area by floodlights mounted on the trailer for night use. For moving around the field, the unit is equipped with a towing tongue. Air brakes operate through conventional hose which may be connected with standard fittings to the source lines on the towing truck. The end of the tongue is equipped with a standard ring which fits any pintle hook attached to the frame of a truck equipped for towing. This versatile pumping unit performs a multitude of jobs in both producing and workover operations. Since its design makes it unnecessary to break connections when moving the unit, equipment life is much longer and the job of moving the unit is simple.



Close-up of trailer tongue, fuel hose drum mounting and tool box. Note pipe unions for removing hose and drum as unit.



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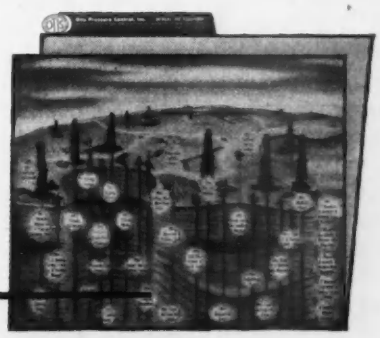

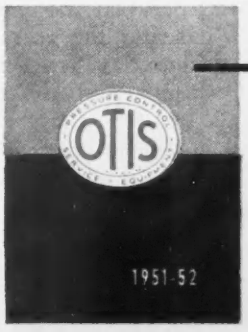

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Testing Gas Wells by BACK PRESSURE Method

By G. W. HEREFORD

Kentucky-West Virginia Gas Company, Inc., Ashland, Ky.

USE OF back-pressure testing is analyzed, and a number of examples carried through, to show how this method can become an accurate indication of a gas well's productivity. The author stresses the necessity for accurate derivation of data, and indicates probable sources of error when the computations do not show the expected correlation. The article is based upon a paper on "Gas Well Testing Methods," presented at a recent Appalachian Gas Measurement Short Course, held in Morgantown, W. Va.

DEVELOPMENT of the "back-pressure" or "Bureau of Mines"[1] method for testing gas wells furnishes the gas industry with a fundamental well testing tool that embodies efficiency and economy in operation. In application it reduces gas losses necessary in taking open flows, saves time, and also reduces the hazards to well structure and equipment encountered by subjecting the well to extreme rates of flow. Furthermore, the method furnishes data not obtainable from open flow which are applicable to the study of such production problems as the capacity of wells to produce gas against various line pressures, fluid encroachment, cavings, salting off, and unsuccessful completion jobs.

In principle, back-pressure tests consist of measuring the rate of flow from a well while some high back pressure similar to operating pressure is held at the well head. Where conditions will permit, the gas may be produced directly into the gathering line during tests. The rate of flow may be measured by any acceptable standard method of measuring flow rate which fits conditions to be dealt with. The usual practice when the well is metered is to use the well meter for measuring the rate of flow during test. On unmetered wells it is well to install permanently in the connecting line a standard orifice flange equipped with valves and connections so that rates may be measured by attaching a manometer and pressure gauge arrangement as described in Figure 3. In cases where the well is not connected up or where the gathering line is not adequate to carry the delivery rate desired for test or where the line pressure is too high to afford adequate tests over sufficient range, the well during tests may be allowed to flow to atmosphere while the rate of flow is measured by a pitot-tube, funnel meter, orifice well tester, critical flow prover, choke nipple, or any other adequate means of measuring flow rate. In some cases the gas may be produced into the gathering line for the high-pressure tests and to atmosphere for the low-pressure tests, or vice versa. In these cases the flow to atmosphere is of short duration and at the same time a high back pressure is held at the wellhead so that the loss of gas and hazards to well structure are relatively small. The hookup as used by the Bureau of Mines engineers is described in Figure 2 showing a conventional orifice plate and manometer for measuring the flow rate, Q, into the gathering line and a critical flow prover at the top of the wellhead for measuring the rate to atmosphere.

In the above-mentioned study, results of tests on gas wells throughout the U. S. show that for normal gas wells there is a consistent relationship throughout the producing range of the well between the rates of delivery of gas and the corresponding pressure differentials between the formation pressure and the sand-face pressure. When the rate of delivery in thousand cubic feet per 24 hours is plotted on logarithmic coordinate paper against the respective difference between the square of the absolute formation pressure and the square of the absolute pressure at the sand face, the resultant is a straight line as shown in Figure 1. This relationship can be expressed mathematically by the equation

$$Q = C\,(P_f^2 - P_s^2)^n$$

where Q = rate of flow, M cubic feet per 24 hours;

C = coefficient (calculated from the equation);

P_f = absolute formation pressure, pounds per sq. in.;

P_s = absolute sand face pressure, pounds per sq. in.;

n = exponent corresponding to the slope of the straight-line relationship between Q and $(P_f^2 - P_s^2)$ or equal to the tangent of the angle between the pressure ordinate and the straight-line curve.

This equation is of value only to those who wish to make special interpretation of gas deliveries. As for general application, interpretations can be made from simple calculations based directly upon the plotted relationship of the curve.

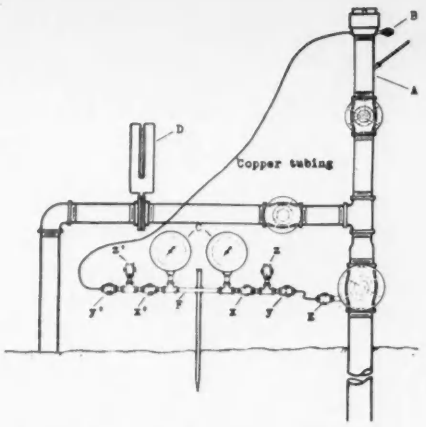
The procedure as set out by the Bureau of Mines engineers for making back-pressure tests require observing the following data:

(1) the diameter of the producing string in inches;
(2) the length of the producing string in feet;
(3) the specific gravity of the gas (air = 1.000);
(4) the absolute shut-in wellhead pressure;
(5) the absolute wellhead working pressure during flow; and
(6) the rate of flow in M cubic feet per 24 hours.

The well to be tested is shut in at the wellhead until the pressure becomes stabilized. The shutin wellhead pressure is observed and recorded. By cracking the control valve at the wellhead, the well is then allowed to produce gas, usually into the gathering line, at some high back pressure until the flow conditions become stabilized. The working pressure at the wellhead

and also the rate of flow for the corresponding working pressure are observed and recorded. Then the back pressure at the wellhead is brought to a somewhat lower point by further cracking of the control valve and a second set of observations made and recorded. The process is repeated to obtain a representative number of working pressures and data. It is essential that the flow conditions be completely stabilized before each reading is taken, and that extreme accuracy be maintained in observing the wellhead pressures on these tests as a small percentage error in the observed wellhead pressure is reflected as a large percentage error in the difference between the squares of the two pressures in the factor $(P_f^2 - P_s^2)$.

After back-pressure tests are completed the data observed must be translated from terms of wellhead pressures into terms of absolute bottom-hole pressures by taking into consideration the weight of the column of gas in the producing string and also the pressure head lost due to friction of this column in motion. This translation can be made direct by reference to the Bureau of Mines Tables 34, 35, 36, 37, and 38 of Monograph 7, which cover a wide range of conditions computed from equations.



A Critical-flow prover
B Prover vent
C Spring gauges to measure wellhead pressure
D Standard manometer or differential gauge
E Connection below wellhead fitting to obtain wellhead pressure
F Pressure gauge manifold
x, y, z, x′, y′, z′ Valves on pressure gauge manifold
P_s Sand-face pressure
P_f Formation pressure

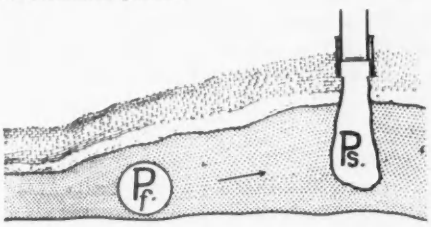


FIGURE 2

Notations used in making computations from back-pressure data are as follows:

P_c = Absolute pressure at wellhead under static conditions when well is shut in, pounds per sq. in.;

P_w = Absolute working pressure at the wellhead when the well is flowing under test, pounds per sq. in.;

P_l = Absolute working pressure when gas is flowing P_w plus pressure drop in the producing string due to friction of the moving column of gas, pounds per sq. in.;

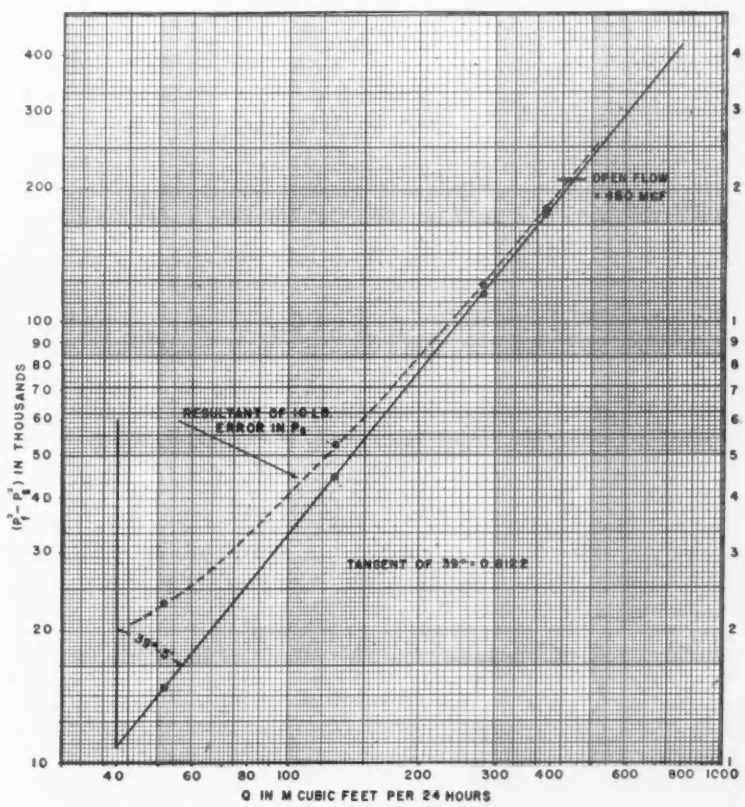
P_s = Absolute pressure at the sand face, pounds per sq. in.;

P_f = Absolute formation pressure or "shutin" pressure in the sand, pounds per sq. in.;

Q = the delivery rate, M cubic feet per 24 hours;

d = internal diameter of the producing string in inches;

L = average length of the gas column in the well in feet;



PLOTTING DATA

Test	Q	P_f	P_s	$(P_f^2 - P_s^2)$
1	51 Mcf	456#	440#	14.3 M
2	128 Mcf	456	404	44.7 M
3	276 Mcf	456	306	114.3 M
4	384 Mcf	456	186	173.3 M

FIGURE 1

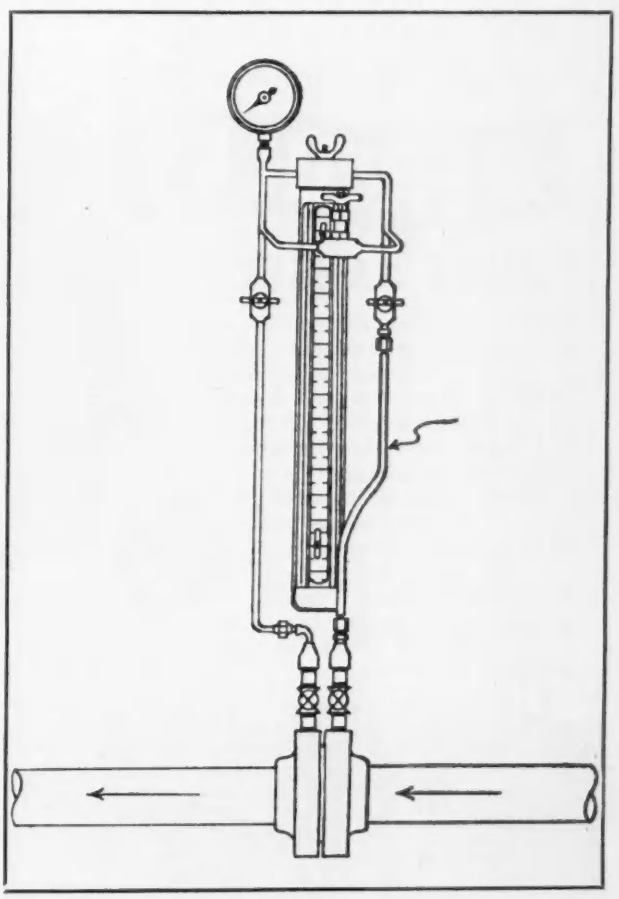


FIGURE 3

G = specific gravity of the gas (air = 1.000);

T = average absolute temperature of the gas in the flow string;

e = base of Naperian (Natural) logarithms = 2.71828;

C = coefficient of the flow formula;

n = exponent in the flow formula = the tangent of the angle between the pressure ordinate and the curve of the plotted relationship between Q and $(P_f^2 - P_s^2)$;

53.34 = Constant for air based on a volume of 12.39 cubic feet occupied by 1 pound of air at 14.7 pounds per sq. in. at 32° F.;

0.0000347 = weight of a column of air 1 inch square and 1 foot high at 1 pound per square inch absolute pressure at 80° F. (80° F. is an assumed average temperature of the moving column of gas).

The computations to be made for interpreting back-pressure data are:

(1) the absolute shutin formation pressure, P_f;

(2) the absolute sand-face pressure under working conditions, P_s;

(3) the value of the pressure factor $(P_f^2 - P_s^2)$;

(4) the rate of delivery, Q, in M cubic feet per 24 hours corresponding to the respective pressure factors, $(P_f^2 - P_s^2)$;

(5) Plotting on logarithmic paper the values of Q against the corresponding values of the pressure factors, $(P_f^2 - P_s^2)$;

(6) Determining the values of the exponent, n, and the coefficient, C, of the flow equation,

$$Q = C(P_f^2 - P_s^2)^n$$

if the equation is to be used;

For examples assume for a well the following observed data:

(1) depth of well, 2000 feet;
(2) size tubing, 2.041 inches;
(3) specific gravity of gas, .675;
(4) absolute shutin pressure at wellhead, 435 lbs.;
(5) absolute working pressure at wellhead, 173 lbs;
(6) flow rate under test 384,000 cubic feet per 24 hrs.;

The absolute formation pressure, P_f, is equal to the absolute shutin wellhead pressure, P_c, plus the weight of the static column of gas in the well. The weight of the static column of gas, $(P_s - P_c)$, is obtained from the equation $(P_s - P_c) = P_c(e^{0.0000347GL} - 1)$, not taking into consideration the deviation from Boyle's law which is relatively small except for very deep wells. Under static conditions $P_f = P_s$, therefore $P_f = P_c(e^{0.0000347GL})$, (1)

Substituting in equation:

$$P_f = 435(2.71828^{0.0000347 \times .675 \times 2000})$$
$$= 435(2.71828^{0.046845})$$
$$= 435 \times 1.04789$$
$$= 456 \text{ pounds per square inch absolute.}$$

For wells on which it is desirable to consider the deviation of gas from Boyle's law the formation pressure, P_f, can be obtained by solving for P_s in the equation

$$\left(\frac{P_s}{1 + P_s b}\right) = \left(1 + \frac{P_c}{P_c b}\right)\left(\frac{GL}{e^{53.34T}}\right) \quad (2)$$

where "b" is the deviation coefficient (deviation per pound per square inch of pressure expressed as a decimal). The deviation factor for 435 pounds absolute (420 pounds gauge) taken from the California Natural Gasoline Association tables is 0.049. Then

$$b = \frac{0.049}{435} = 0.0001$$

Substituting in equation

$$\left(\frac{P_s}{1 + P_s \times 0.0001}\right) = \left(1 + \frac{435}{435 \times 0.0001}\right)\left(\frac{.675 \times 2000}{e^{53.34 \times 540}}\right)$$

$$= 416.866(2.71828^{0.046869})$$
$$\text{Log } 2.71828 = .434294$$
$$.434294 \times 0.046849 = 0.020355$$
$$\text{Antilog } 0.020355 = 1.04791$$
$$= 416.866 \times 1.04791 = 436.838$$

$$\left(\frac{P_s}{1 + 0.0001P_s}\right) = 436.838$$

$$P_s = 436.838(1 + 0.0001P_s)$$
$$= 436.838 + 0.043684P_s$$

$$P_s - 0.043684\,P_s = .956316\,P_s = 436.838$$

$$P_s = \frac{436.838}{.956316} = 456.8$$

$P_f = P_s$ under static conditions = 456.8 pounds per square inch absolute.

To solve for the absolute sand-face pressure, P_s, under working conditions it is necessary to substitute for P_c in the equations the absolute wellhead working pressure, P_w, plus the pressure head lost due to friction of the moving column of gas. This factor is designated as P_l, and is computed from Weymouth's formula for flow through horizontal lines.

$$P_l = \sqrt{P_w^2 + \left(\frac{Q\sqrt{GL}}{48{,}960\ d^{8/3}}\right)^2} \quad (3)$$

Substituting in equation: $P_l =$

$$\sqrt{(173)^2 + \left(\frac{384.000\sqrt{.675 \times 2000}}{48{,}960 \times 2.041^{8/3}}\right)^2}$$

$$\text{Log } 2.041 = .309843$$
$$.309843 \times 8/3 = .826248$$
$$\text{Antilog } .826248 = 6.70261$$

$$P_l = \sqrt{29929 + \left(\frac{14{,}109{,}000}{48{,}960 \times 6.70261}\right)^2}$$

$$= \sqrt{29929 + 1{,}849} = \sqrt{31{,}778} = 178$$

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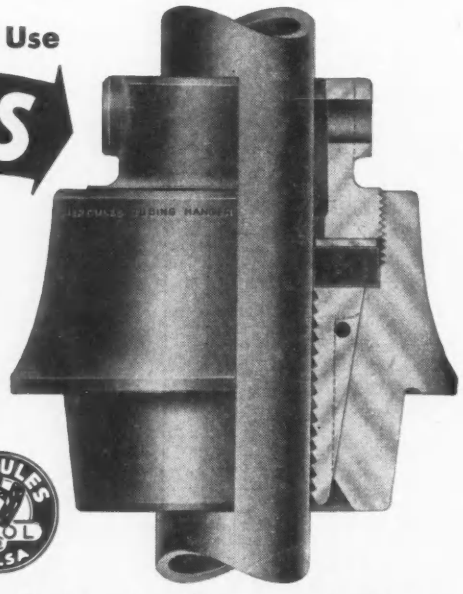

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$P = 178$ pounds per square inch absolute.

Then substituting P_1 for P_c, equation (1) becomes $P_s = P_1 (e^{0.0000347GL})$ (4)

Substituting in equation P_1 for P_c from Equation (1):

$P_s = 178 \times 1.04789 = 186$ pounds per square inch absolute.

Pressure factor $(P_f^2 - P_s^2)$ becomes by substitution

$(456 \times 456) - (186 \times 186) = 173{,}340.$

For presenting the relationship between the rate of flow Q, and the pressure factor $(P_f^2 - P_s^2)$ graphically as in Figure 1, only the following three factors are needed:

Q, the rate of flow in M cubic feet per 24 hours;
P_f, the absolute formation pressure, and
P_s, the absolute working pressure at the sand face.

The rate of flow, Q, is plotted on the X ordinate against the pressure factor $(P_f^2 - P_s^2)$ on the Y ordinate. In presenting Figure 1 assume for the above mentioned well the following test data:

Test No.	Abs. Working Press. at Wellhead, P_w	Rate of Flow, Q. MCF Per 24 Hrs.
1.	420 lb.	51 M Cu. Ft.
2.	385 lb.	128 M Cu. Ft.
3.	292 lb.	276 M Cu. Ft.
4.	173 lb.	384 M Cu. Ft.

When these data are translated into bottom-hole conditions, the following are the computed plotting data:

Test No.	$(P_f^2 - P_s^2)$	Q in MCF Per 24 Hours
1.	$(456)^2 - (440)^2 = 14.3$ M	51 M
2.	$(456)^2 - (404)^2 = 44.7$ M	128 M
3.	$(456)^2 - (306)^2 = 114.3$ M	276 M
4.	$(456)^2 - (186)^2 = 173.3$ M	384 M

When these data are plotted on logarithmic paper as in Figure 1 the resultant is a straight line.

By plotting two or more representative tests in the above manner the resultant straight line may be extended beyond the range of the plotted points to indicate the open-flow of the well and the rate of flow corresponding to any condition the well might present.

Sometimes the results obtained from back-pressure tests appear to be inconsistent when plotted. These inconsistencies may be an indication of the need for further study of the well conditions or may be caused by factors which result in errors in the computed values of the pressure at the sand face, or incorrect measurement of the delivery rate from the well. The results of back-pressure tests of gas wells can be interpreted properly only when there is a thorough understanding of the cause and effect of error in the back-pressure data. Some of the common fac-

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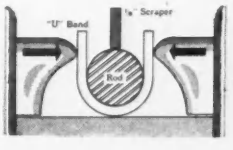
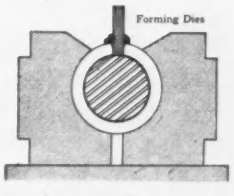


Cross section showing "U" band being die-formed around rod to the scraper blades.



Cross section showing band held under pressure around rod while ends of bands are shrink-grip attached to scraper blades.

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tors which cause error:

1. Incorrect well head pressures.
   (a) Inaccurate gauging instruments.
   (b) Unaccounted-for pressure drop between the head of the flow string and the gauge connection.
   (c) Dynamic effect of the impact of gas flow.
2. Error in calculated pressure drop in the producing string due to friction.
   (a) Bridged hole, cavings or collapsed casing.
   (b) Incorrect density of the gas.
   (c) Inaccurate measurement of delivery rate.
3. Error in the calculated weight of the gas column in the well.
   (a) Unaccounted-for liquid in the well bore.
   (b) Incorrect temperature of the gas.
   (c) Incorrect density of the gas.
4. Inaccurate measurement of delivery rates.
   (a) Unaccounted for leakage of gas from the casing.
   (b) Sub-surface migration of the gas.
   (c) Unaccounted-for leakage of gas between the wellhead and the measuring device.
   (d) Inaccurate measurement instruments.

A graphic presentation of the effect of a ten-pound error in the computed sand-face pressure of the well in the above problems is illustrated by the dotted curve in Figure 1.

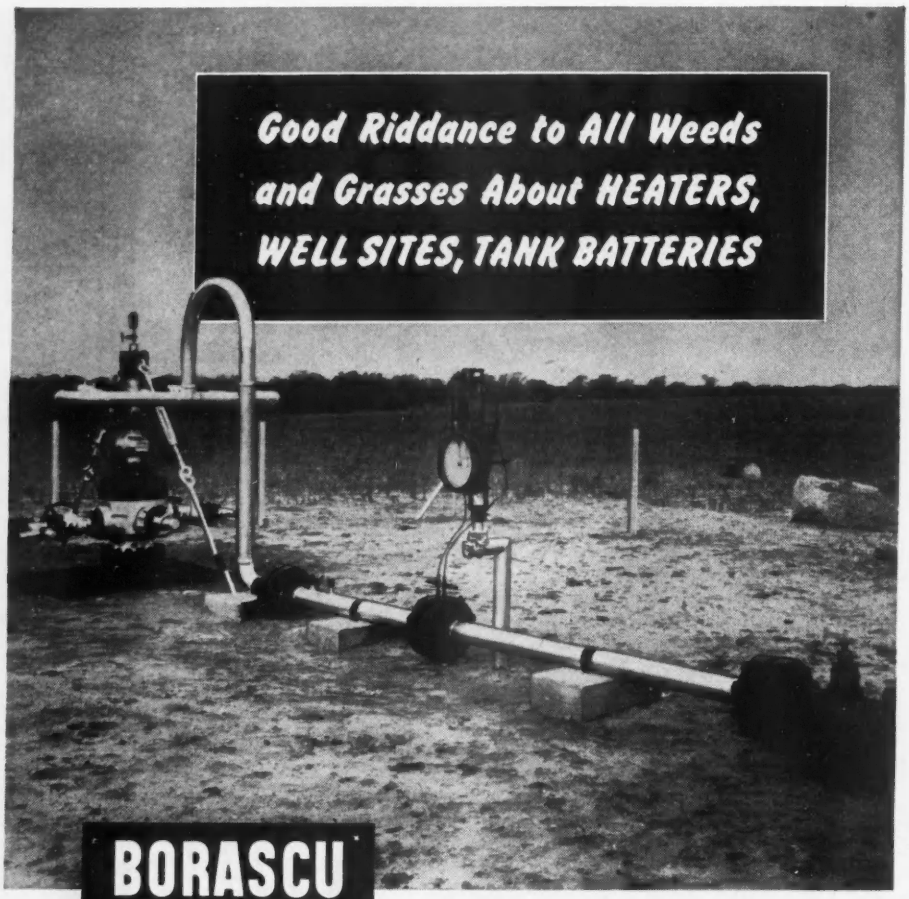
Back-pressure tests at different times in the productive life of normal gas wells indicate negligible variation in the producing characteristics of the wells; that is, the relationship between the flow rate, Q, and the pressure factor ($P_f^2 - P_s^2$) remains practically the same. When this is true, results of earlier tests may be used as a basis for determining probable deliveries at later dates. There are many natural and common factors, however, that tend to change the delivery capacities of wells at different periods in the producing life and therefore occasional complete tests should be made from time to time on all wells even though all previous tests have shown no change in flow and pressure factor relationship. Sudden change in producing characteristics suggests fluid coning or enroachment, liquid in the well, cavings or encrustation in the well bore, or other detrimental conditions. The effects on well delivery of such work as cleaning out, acidizing, shooting, etc. are also revealed by back pressure curves.

For gauging pressures where a high degree of accuracy is essential, as in making back-pressure tests, it is always preferable to use a dead weight gauge. Spring type gauges are serviceable for this purpose, however, if care is observed in keeping them accurate. It is recommended that two such gauges be used simultaneously as a check against each other for this purpose.

If it is necessary to exhaust the gas to atmosphere when making back-pressure tests the instrument preferable for measuring the rate of flow depends largely upon the capacity and pressure of the well being tested. For low pressure and small capacity wells the orifice well tester is quite ideal. Also the funnel meter may be used as in taking open flows. For larger capacity wells the critical flow prover is the preferred instrument. Also the pitot-tube may be used. In cases of extremely large capacity wells where the gas carries considerable abrasive material which might damage a critical flow prover or pitot tube, it is well to use a choke nipple for measuring the rate of flow.

REFERENCE

[1] Bureau of Mines Monograph-7, "Back-Pressure Data on Natural Gas Wells and Their Application to Production Practices."



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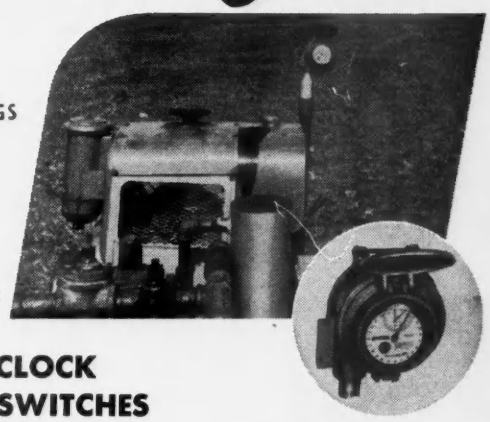

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CLOCK SWITCHES

Enardo "MB" and "A" Time Cycle switches offer a positive accurate shut-off control of engine operation time-schedules. Hand-wound and precision built to either 12 or 24 hour movements these switches are enclosed in dirt, moisture and vapor-proof cases. A micro-switch control is utilized for the "MB" series with mercoid tube operation for the "A" group. Write for a complete description and price list. For Canadian delivery contact National Tank Co., Ltd., Box 4184, Edmonton Station, Alberta, Canada.

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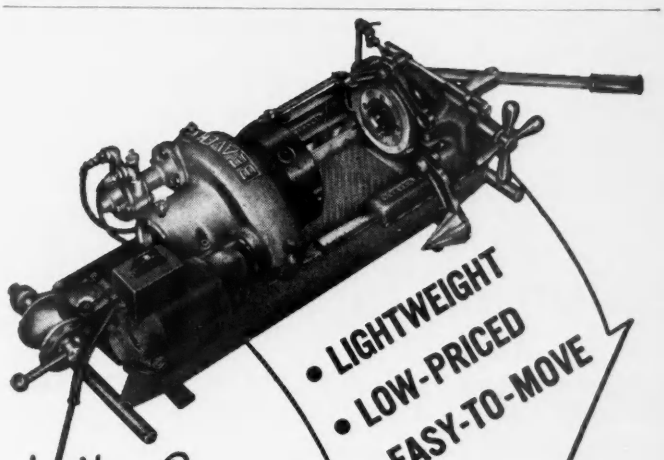

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the New Beaver Model-E Pipe and Bolt Machine

The new low-priced, lightweight Beaver Model "E" is a "junior edition" of the heavy-duty Beaver Model A—which has, for the past 20 years, been the recognized leader in the field of portable pipe and bolt machines.

Although designed primarily for hardware stores and small piping contractors and industrialists, BIG contractors will find the new Model "E" useful on jobs requiring extreme portability.

A pipe machine is no better than the service back of it and our 50 years of experience in this field, and our reputation for high quality and friendly service, is your best guarantee of complete satisfaction.

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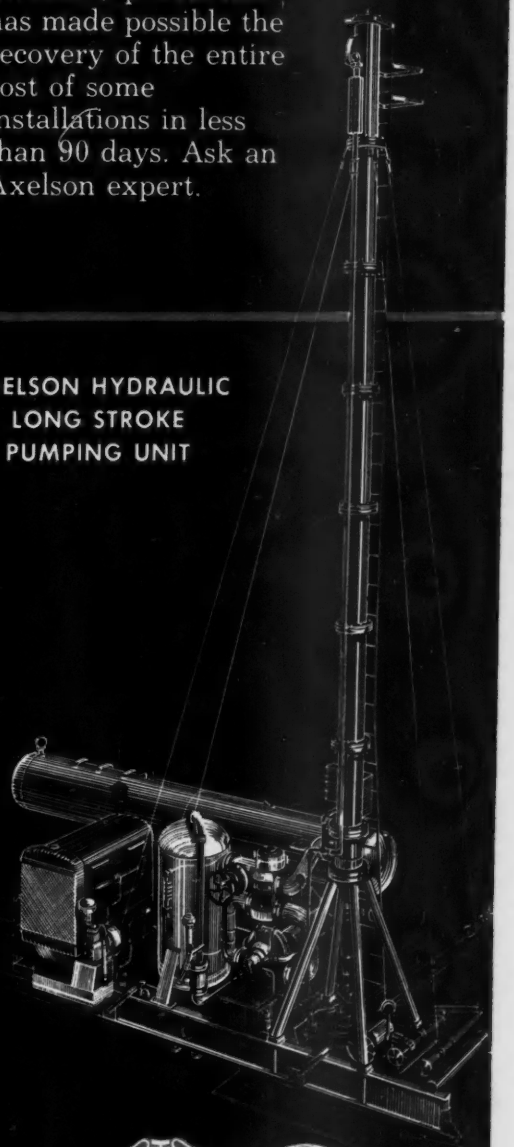

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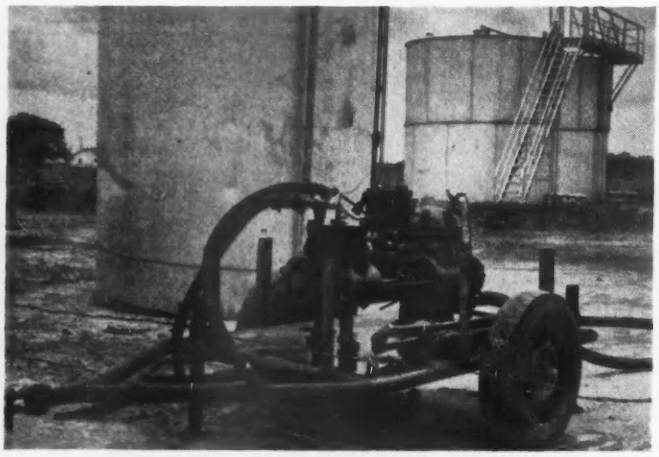
How to do it! PRODUCTION HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

HOW TO—Increase Flexibility of Lease Utility Pump

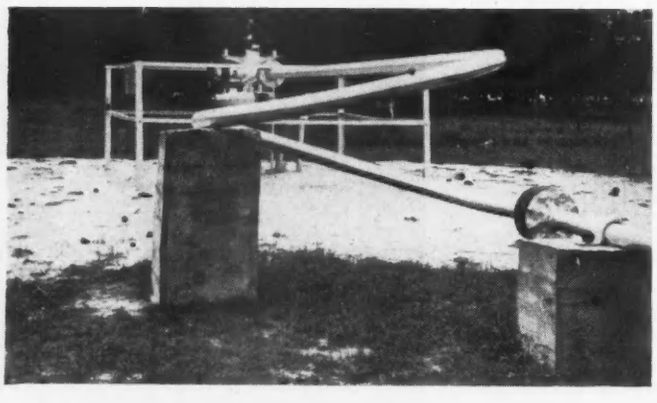


The use of one utility pump about the lease to perform a multitude of jobs can result in a considerable saving in equipment investments. If a pump were permanently set up on a concrete foundation at each point on a lease or field where such equipment is occasionally needed, there would be considerable duplication of these items. The usefulness of a utility pump, such as found on many leases, can be materially increased by making it portable and equipping it with flexible hose to facilitate hooking up connections.

Illustrated is a 6 x 4 x 6 steam pump that has been trailer-mounted and converted for using either steam or gas pressure as a source of power. Automobile wheels are mounted on the ends of a length of angle iron welded to the trailer framework, without adding springs or shock-absorbing gear. The trailer frame is made of three-inch salvaged pipe in a conventional manner as shown. A simplified trailer hitch made of discarded pieces of heavy-duty rotary chain is constructed so that a bolt inserted through the ends can connect to a common eye trailer hook attached to a lease pickup truck.

Flexible rubber hose is used throughout where possible. Gas inlet lines are connected to the nearest separator line, while the discharge line is laid on the ground to extend a safe distance from the battery or point of use. Oil-resistant hose is also used on the fluid connections, depending upon the service performed by the pump. High-pressure, flexible steel hose is provided for use where high pressures were needed. The pump has such uses as rolling tanks, transferring crude oil from a temporary test tank into stock tanks, for cleaning out tanks, and removing oil from skimming pits. It is light enough and equipped with rubber hoses so that one man can hook it up for operation.

HOW TO—Compensate Expansion on Injection Line



The problem of compensating for expansion on high-pressure gas injection lines can be solved in the simple and inexpensive manner illustrated. Temperature is not a real problem in gas injection programs, and for this reason, there are usually no heat exchangers on the discharge of the high-pressure stage of compression in pressure maintenance projects. In fact, temperatures above the dew point are desirable in the prevention of hydrate formation in such distribution lines. However, in taking advantage of the higher temperatures in gas injection distribution lines, the problem of expansion and contraction of the heavy-duty line must be handled.

Expansion loops have proven to be satisfactory and practical but are awkward in placing in the line. In the illustration an expansion loop is placed in a high-pressure gas injection line in a nearly horizontal position. In this manner, it can be handled more easily when it is necessary to connect or break out the line from the injection well. The flange connection at the christmas tree and the concrete foundation block shown at right serve as the two supports for this loop. A concrete block is used to remove the torsional load from the flange bolts. Expansion in the line due to temperature changes is absorbed in this loop, and stress is removed from the wellhead. The line tie-down at the anchor block at right will permit movement of the line downstream so that the loop will take up the movement up and down the line for a considerable distance.

GULFCO'S 32 YEARS HAS SEEN OIL BECOME THE MEASURE OF A NATION'S STRENGTH

GULFCO was 'reared' in the BEAUMONT • SPINDLETOP AREA

. . . . which was and is an area of most exacting requirements — an unexcelled proving ground for keeping Gulfco products advanced in design, proved in use,

...LEADERS THE WORLD OVER

CRISIS TO CRISIS

Gulfco's 32 years spans the most exciting and most critical era in history—World War I, World War II, and the present crisis—a period when oil is a *sine qua non* of a nation's strength. The balance of nations is changed by oil discoveries. The word "oil" is, more than any other, heard in the embassies of the world. The seeking of oil often brings nations into conflict, and oil is a big factor in the winning of wars.

Gulfco's technical progress in its field has kept pace with the demands of the great oil industry.

GULFCO TYPE FO TUBING HEADS

. . . are furnished in four principal types. Each type is assembled with one standard full opening forged steel body which is designed for 4000 PSI test pressure or 2000 PSI cold working pressure.

Each type can be converted to the other by an interchange of parts regardless of casing size. These tubing heads can be furnished, male or female, in casing sizes from 5" OD to 7" OD to accommodate 2", 2½" or 3" regular or upset tubing. Two 2" API line pipe side outlets are regularly furnished.

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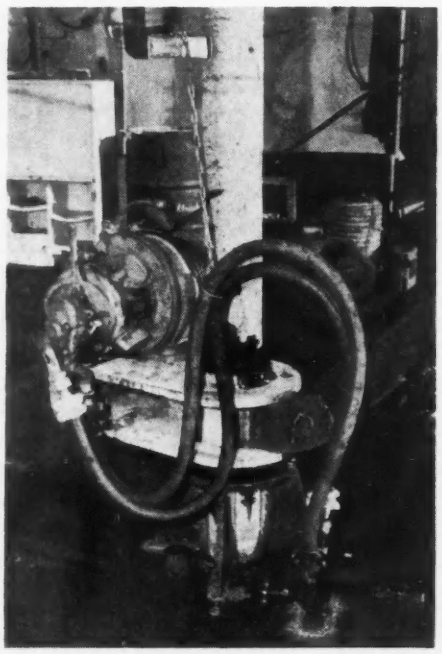
HOW TO— Power Boom Winch at Marine Installation

Here is an arrangement that saves considerable space and simplifies design problems on a producing platform in a marine field. One of the more serious problems encountered on such confined structures is that of fire hazards. Since it is almost impossible, if not impractical, to prevent the escape of some gases around the producing equipment, it is necessary to remove all sources of spark or fire.



There are two conventional ways to power a boom winch used in loading and unloading equipment and material from such platforms. One involves a hand winch that is time and labor consuming. The other usually includes the installation of a small internal combustion engine to drive the winch. The first, while practical, is not desirable to remove heavy loads from small boats. The second is too hazardous to warrant the expenditure necessary to make it spark free. In view of these two considerations, a third method was used at the installation pictured. Since there is plenty of gas at relatively high pressures available from the separators, it was decided to use a pneumatic motor winch such as has found acceptance on drilling rigs to power the catline.

The base of the stiff leg boom is shown. The vertical supporting leg extends through a foundation assembly welded to the floor plates of the platform. Revolving around the supporting upright member is a larger-diameter pipe. This moving segment has a bearing surface on its lower end where the foundation for the air-motor is welded as shown. Gas supply and exhaust lines are connected to the floor near the boom, and flexible rubber hoses convey the gas to and from the motor through throttle controls. The winch and air-motor are integrated, and therefore the operator may keep one hand on the brake and one hand on the motor throttle.

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JET PERFORATORS
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They assure penetration from every shot fired . . . eliminate hit-or-miss perforation

Du Pont Jet Perforators assure positive penetration with every shot. These perforators are high-explosive charges that readily penetrate the surrounding formation up to three times deeper than other methods. In fact, they are the most effective perforating tools available to the oil industry and are widely used by experienced service organizations.

You are certain of the maximum production possible when your service company uses Du Pont Jet Perforators. They easily penetrate even *three* strings of casings and cement to promote a greater flow of oil. Their scientific design and uniformity, from careful control during manufacture, consistently obtain predictable results. In addition, "Jets" are fired simultaneously, insuring symmetrical perforating patterns.

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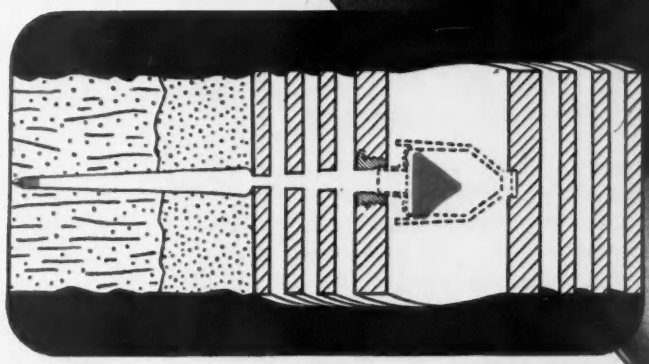
Be sure to ask your service company to use Du Pont Jet Perforators on your next well job. You'll agree they perforate better . . . step up production. Write today for your free copy of the illustrated bulletin on Jet Perforators. It tells what they are and what they can do for you. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.



One, two and even three strings of casings, neat cement and the surrounding formation are readily perforated by Jet Perforators. Penetration is up to three times deeper than other methods allow.

Du Pont Jet Perforators are manufactured with a plastic shell containing a shaped charge with a conical copper liner. They produce a jet of tremendous penetrating power.

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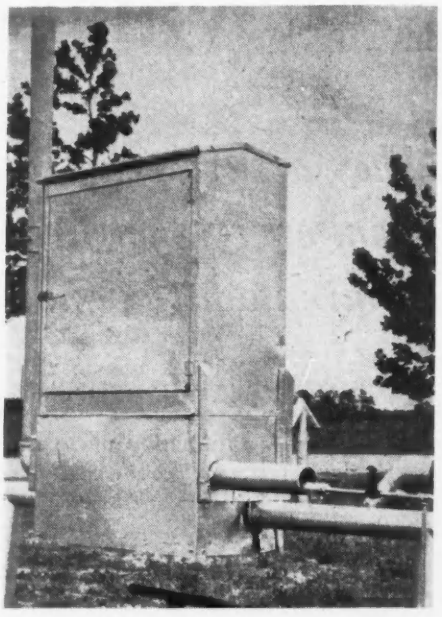
HOW TO— Warm Housing of Gas Line Orifice Meter

Maintaining warm temperatures inside an orifice meter housing can be successfully and economically accomplished by the addition of a small gas-burning heater as shown. This heater not only prevents hydrate formation downstream of the orifice plate in a high-pressure gas transmission line, but permits the meter mechanism to operate smoothly. Low temperatures due to winter conditions, and the refrigeration effect resulting from the expansion of high-pressure gas through the orifice plate, do not make for efficient meter operation.



An orifice meter was mounted on the high-pressure gas line to which was connected the orifice plate adapter, and a galvanized sheet metal housing was added. In order to provide heat around the orifice plate adapter in the gas line, it was necessary to extend the housing with a skirt so that it enclosed the line and the meter. This was done by merely adding a sheet metal extension to the regular meter housing, removing the bottom of the purchased housing and adding a new bottom below the gas line.

A three-inch line was extended horizontally through the new housing skirt and equipped with a short stack as shown. This stack is about five feet long and contains a built-in dampener that can be adjusted according to the amount of heat required inside the housing. The heating element is fired by a one-inch connection from the lease gas system, and the size of the flame is controlled through a needle valve. In this manner, the flame is kept from inside the meter housing where slight gas accumulations would be dangerous. The modifications on the purchased meter house, which were made at a nominal cost, eliminate considerable trouble.

★ For working pressures from 1500 to 3000 lbs.
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★ Bean is quickly and easily replaced
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O-C-T THREADED ADJUSTABLE CHOKES GIVE YOU
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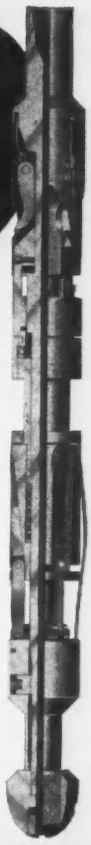
O-C-T HAS PIONEERED HIGH PRESSURE CONTROLS

QUICKER SAFER PIPE CUTS WITH The BOWEN CASING CUTTER



The Bowen Casing Cutter is a precision tool for cutting casing, drill pipe and tubing. Ideal for use with Bowen Jars and Spears for all types of cut-and-pull operations. Simple to operate and won't slip down pipe after cutting begins. Withstands operating stresses at all depths. Can be set and released as often as desired without coming out of the hole.

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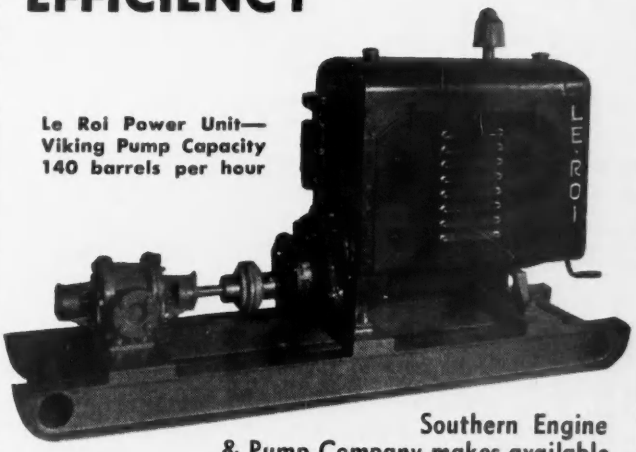

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140 barrels per hour

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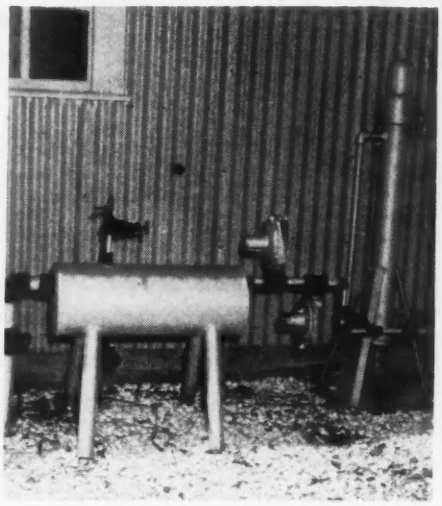
HOW TO— Scrub Field Gas for Compressor Engines

Field conditions vary, making the extent of cleaning field gas different from one field and lease to another. Generally, it is necessary only to set up a single vertical scrubber to remove solids from the gas supplied to engines driving pumping units or other equipment. In the installation shown, gas is furnished to a vertical engine-driven compressor that increases field gas pressure to a sales line pressure. The gas

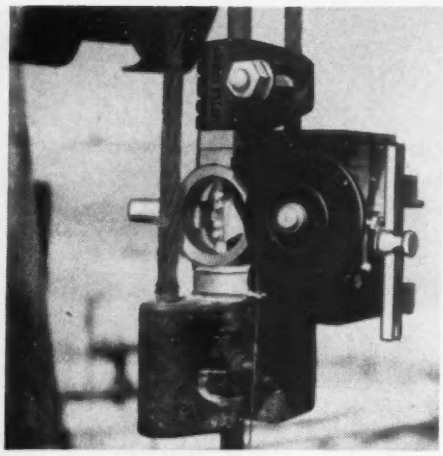


not only contains foreign particules, such as sand and slivers of rust, but has entrained in it some water as well. Two scrubbers are used to clean the gas for the engine fuel. One scrubber is the vertical type and the other horizontal. The horizontal unit is of conventional design, with gas entering one end and discharging out the other end. On both end connections the lines are welded into the top of the horizontal chamber. Baffles inside the scrubber knock out any solids in the gas. A blow valve on the bottom permits the scrubber to be cleaned periodically.

Gas entering this first horizontal unit is considerably higher in pressure than the four ounces required to feed the engine, but since an adequate supply is necessary, this relatively high pressure is desirable. A pressure relief valve placed on top of the chamber releases excessive gas pressure to prevent rupture of the diaphragm on the regulator immediately downstream of the unit. A second regulator further reduces the pressure to operating values before the gas enters the final vertical scrubber, which removes any condensates or water that carry over. Gas enters the vertical unit near the upper section, and an outlet, also in the upper part of the scrubber, carries the fuel gas directly into the engine carburetor. This vertical chamber is made of eight-inch casing threaded on the upper end to accept a collar and bull plug end. The plug can be removed for inspection. A bottom drain makes it possible to draw off liquids that fall out.

IT PAYS TO KNOW!

Make More Profits From Marginal Wells
WITH J-F DYNAMOMETER



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About 80% of all wells checked for counterbalance are found to be out of balance in varying degrees. The J-F Dynamometer measures the counterbalance effect at the polished rod. This enables accurate adjustment for normal pumping operation.

Pulling of "GREEN PUMPS"
Unnecessary pulling of pumps result in extra labor, material costs and downtime. The operations of your pumps may be checked at the surface in a few minutes with a J-F Dynamometer. The test can be made by the foreman, head roustabout or other personnel.

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Sucker rod failures are caused by load. The J-F Dynamometer records the load at every point in the stroke so that detailed analysis can be made and corrective measures taken.

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Based on *facts*, accumulated dynamometer information is extremely useful in selection and installation of proper design and size of equipment.

SIMPLICITY OF OPERATION
The simplicity of operation of the J-F Dynamometer has greatly widened its use for *operational control*. For example, inexperienced personnel, after one day's instruction, can operate the instrument.

JOHNSON-FAGG
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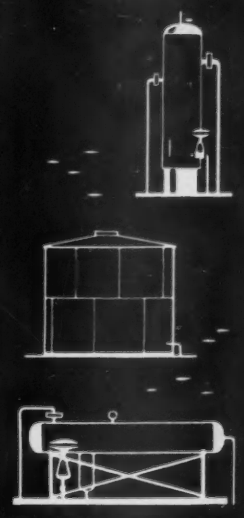
To the casual observer two sheep may look alike. But, to the judges . . . learned and experienced in the characteristics of sheep . . . there is a vast difference.

Steel tanks, oil and gas separators, and emulsion treaters are not awarded blue ribbons like sheep, but vast differences exist.

That Maloney-Crawford is a champion is not only a heritage, passed down through the years, but a fact brought about by the constant awareness of better designing, better materials, and better skill.

Since the day when Maloney-Crawford introduced the first bolted steel tank, there has been exhaustive research and effort to seek out every means of providing better products to the oil industry.

So, when you buy or specify steel tanks, oil and gas separators, or emulsion treaters . . . insist on a "champion" . . . insist on Maloney-Crawford.



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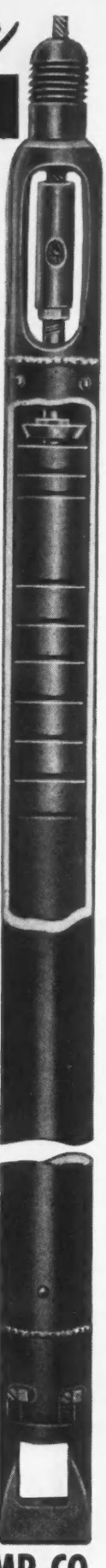
Miller SAND PUMPS



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The Miller Sand Pump is made in regular and heavy duty types in sizes listed below. Lug type, chisel, sand and bailer bottoms are easily interchanged.

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Outside Diameters

2½"
3"
3½"
4¼"
5"
5½"
7"

Lengths

20 feet
25 feet
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Special Sizes and Lengths Made to Order!

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PRODUCTION HINTS

HOW TO— Equip Well Service Unit

A combination bumper, jack stand and guy wire anchor was developed to be attached permanently on a heavy-duty well servicing unit. This combination, which replaces the conventional bumper, is made of a convenient length of six-inch pipe fitted with connections and bolted on the front spring horns where the original bumper was placed. The bumper is slotted on the front surface to attach cables for towing heavy equipment.

Each end of the bumper is fitted with sockets to insert combination screw jacks having matching holes in the stem and socket to make rough adjustments on more or less uneven ground, or on the surface of a concrete apron at the well or group of wells. The jacks fit on large rectangular footing plates with adequate surface to maintain ordinary positions when set on hard soil. Adjusting pins for the matching holes in the jack stand and sockets are permanently attached to the bumper with light chains to prevent misplacement.

For the guy lines, heavy clevises are

welded to the extreme end of the six-inch pipe to receive the eye of turnbuckles. A rod with side braces is welded in the exact center of the bumper on the lower side where a conventional oil field step jack can be placed to lift the front of the unit when making rough adjustments with the screw jacks at each end.

if it's a CATAWISSA . . . it's DEPENDABLE!

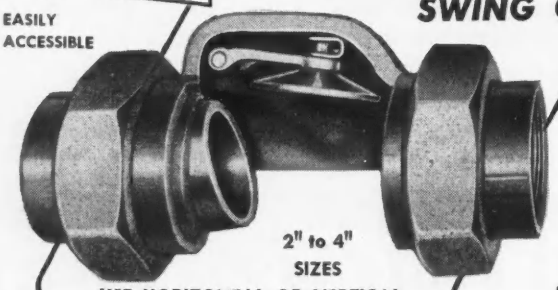
NEW! now . . . FULL OPENING for unobstructed flow!

COMPACT
EFFICIENT
EASILY ACCESSIBLE

CATAWISSA DOUBLE UNION SWING CHECK VALVES

FLOW LINE AND PIPE LINE TYPE for general use

designed for use in lines where no stop is installed close to the check valve and where pipe cleaning mechanisms (go-devils) are used!



2" to 4" SIZES
USE HORIZONTAL OR VERTICAL

Here it is . . . Catawissa's newly improved, full opening valve with union connections on both ends to permit breaking the line at inlet end with check holding contents of the line!

Recommended for 250-lbs. Working Steam pressure 500-lbs. Oil, Water, Gas Tested 1000-lbs. NSHP

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SUCKER ROD BOOKLET

This 12-page, illustrated booklet gives complete information about Bethlehem Sucker Rods, Pony Rods, Couplings, and related products. A copy will gladly be sent to you on request.

They'll keep the strings in the hole

These four Bethlehem Sucker Rods cover such a wide range of pumping conditions — from medium pumping-duty in mild wells to heavy pumping-duty in difficult wells — that you can count on them to meet your needs.

Bethlehem Sucker Rods are good, economical rods because they are well made, and are designed to keep strings in the hole for long periods of time. They reach you in good condition because they come in a time-saving unit package which holds the rods firmly and facilitates handling.

For full information about Bethlehem Sucker Rods, check with the nearest Bethlehem sales office or sucker-rod distributor. Or drop a line to us at Bethlehem, Pa.

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BETHLEHEM STEEL

BETHLEHEM *Sucker Rods*

WATER DROP OR DELUGE?

A REDA

SUBMERGIBLE - ELECTRICAL PUMP delivers the RIGHT amount . . . DEPENDABLY, ECONOMICALLY FOR SECONDARY RECOVERY from Pilot Stage to Full Flood . . .

ENGINEERING DESIGN

Reda Pumps produce the largest volumes obtainable from 5½", 7", 8⅝" casings, often reducing the required number of source wells. Corrosion resistance built into Reda Pumps materially prolongs time between pulling jobs, where corrosion is a factor.

ECONOMY

Reda Pumps reduce investment in number of supply wells required. Reda pumping equipment investment is less per barrel of daily capacity; pumping cost per barrel is lower.

FLEXIBILITY

To fit the changing needs for water volume as the flood progresses, Reda Pump can readily be altered or changed to larger or smaller sizes.

Reda Engineers have been closely associated with WATER FLOOD OPERATIONS for more than ten years and are fully qualified to assist operators in the selection of proper pumping equipment. A letter or phone call will bring prompt results.

REDA

PUMP COMPANY

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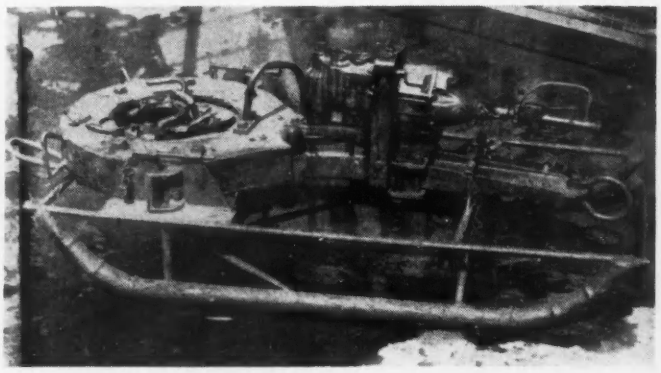
BARTLESVILLE, OKLAHOMA

PRODUCTION HINTS

How to—Store Motor-Driven Tongs



Since the air-motor driven tubing tongs should be handled and stored carefully, a frame has been made into which the tool is placed to remain permanently, except when in actual well service. The sills for the tong carrying frame resemble a double ended sled, and are made of two-inch pipe shaped with a torch to form belly wrinkles in sequence at the bends. Sucker rods are used for cross members and braces and a towing loop at one end. The two handles on either side of the tong head lie on angle iron plates welded to the top frame and slotted so the handles fit snugly. Loops are turned in the upper part of the steel plate to insert safety pins so the tool cannot be removed before these pins are removed.

Another cross member welded where the shank of the wrench extends backward is fitted with similar loops for locking in place. By shaping the sills as double ended runners, the assembly can be towed easily from one location to another, particularly when the wells are grouped only a short distance from each other on directional drilled leases. The loop commonly used to suspend the wrench at working height when breaking out strings, or running them back into the hole, is used for lifting the unit from the ground to a pickup when moving any distance.

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the dependable, economical water treater

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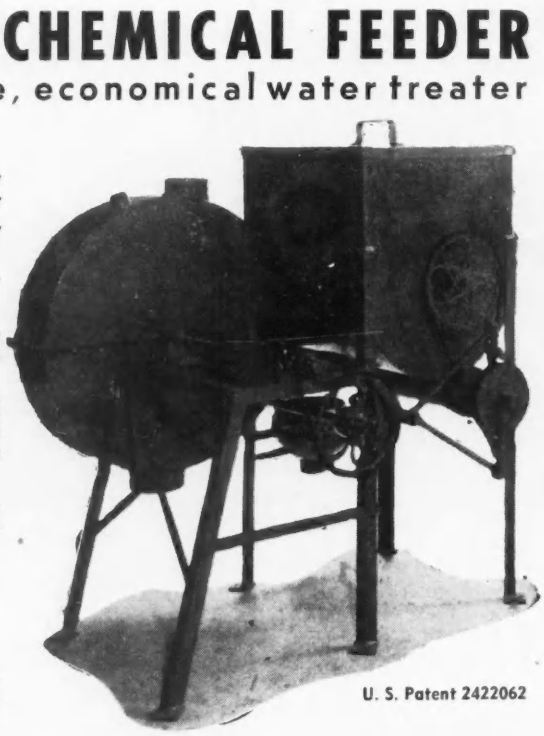
- Maintains pre-set water-Chemical ratio through a wide rate-of-flow range.
- Adjustable two ways, to feed from a few pounds to several hundred pounds of chemicals per day.
- Also can be equipped with electric motor, or gas engine drive.
- Made to your specifications in various sizes.
- In use the world over.

Whatever your water treating problems may be, investigate the Western Feeder. Write for literature and prices.



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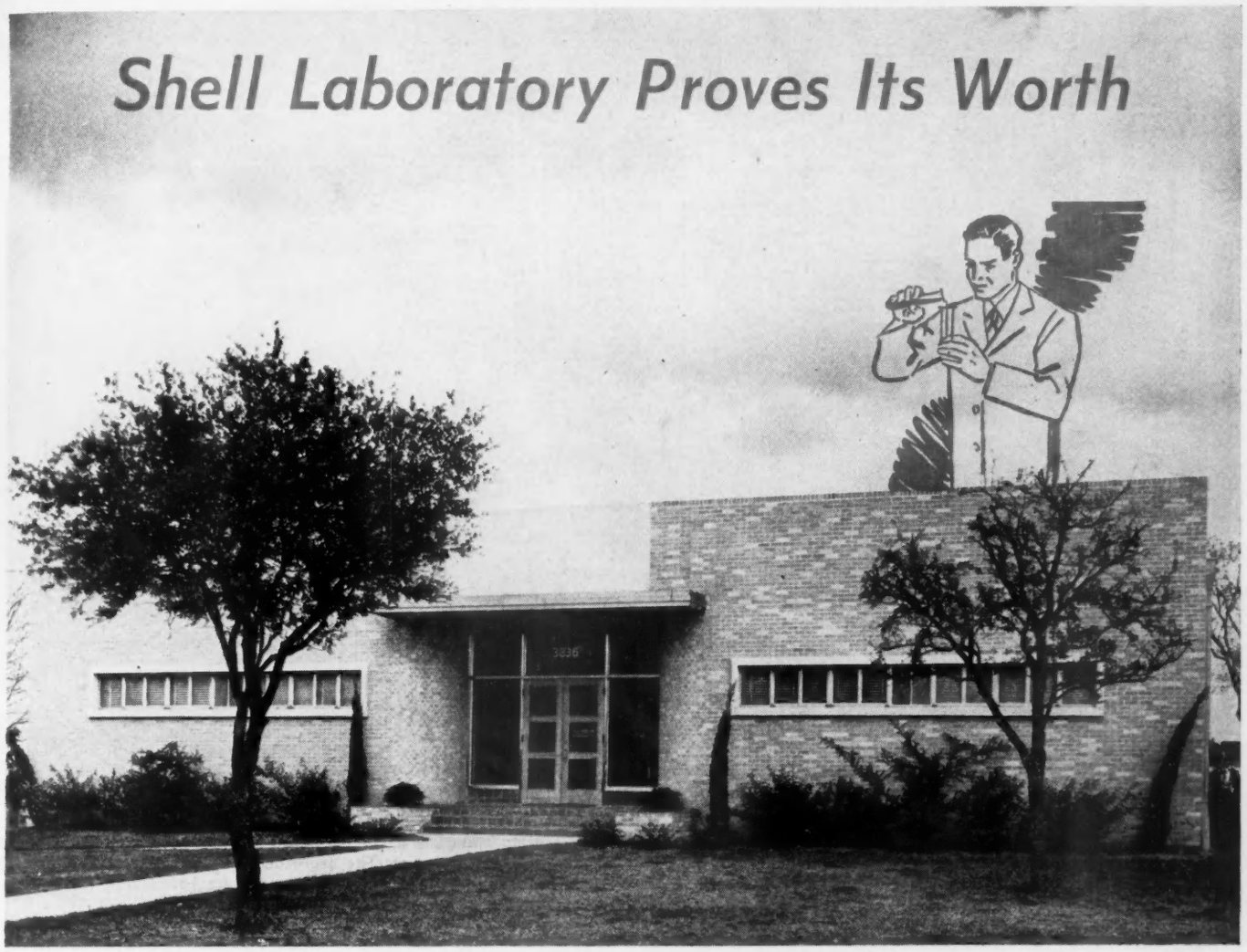
Shell Laboratory Proves Its Worth



PRODUCTION, drilling and exploration branches of the petroleum industry have proven that research and experimentation will pay rich dividends. Shell Pipe Line Corporation made the reasonable assumption that research and experimentation in the pipe line industry will also be rewarding, and has organized and equipped a full-time research staff.

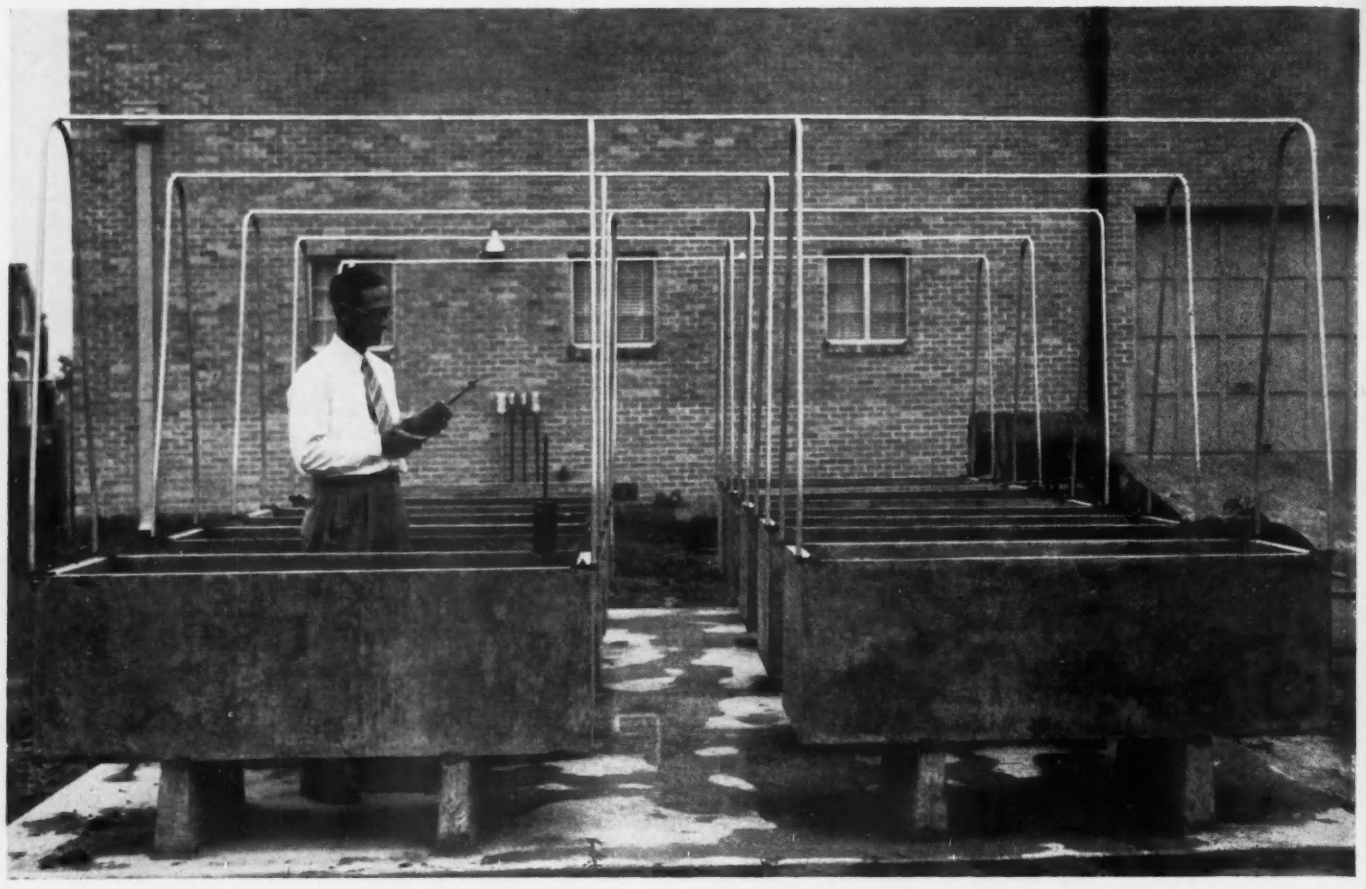
DOWN-TO-EARTH, common-sense research on everything from pipe coating to weed killers is being carried on at Shell Pipe Line Corporation's new Experimental Engineering Laboratory in Houston. This laboratory, one of few engaged in pipe line research, has proven its worth, although the plaster is hardly dry in the new building it shares with two other Shell subsidiary laboratory groups. It has a three-fold purpose:

- Providing a technical and consulting service for other departments,
- Improving existing equipment and operating methods,
- Developing new equipment and operating methods.

Its staff, equipment and buildings, although small, compare favorably with the best in any field. But what makes Shell's laboratory unusually noteworthy is that it exists at all. Many executives in the pipe line industry have been hesitant to appropriate funds for experimentation and research. Shell, however, realizing the value of research, placed its faith in the practical benefits of such a venture.

What now constitutes the staff of the laboratory was organized several years ago by Vice President H. H. Anderson and Chief Engineer D. H. Lewis as a special projects group whose purpose was to assist the Engineering and Operating departments by handling various projects that required special study and laboratory or field experimentation. This group, under the general guidance of Corrosion Engineer O. C. Mudd, who is in charge of research corrosion and associated problems, and J. E. Green, who directs general engineering projects, at that time had no quarters of its own and used spare offices and company garages as headquarters.

The laboratory's experimental work is not of the dramatic, dial-twisting variety aimed at revolutionary discoveries. Indeed, one of its most ambitious projects is the far-from-glamorous testing of hundreds of recently developed paints and pipe coatings. This work, though far from finished, already bears fruit. Four or five new and excellent insulating materials have been selected from the hundreds



Coffin-like vats containing crude-soaked corrosive soil are used in testing pipe coating materials under accelerated conditions. Corrosion Engineer Lyle R. Sheppard examines a magnesium test cylinder that has been coated with an insulating paint. The overhead framework is electrical conduit through which electrical connections are made to an instrument panel inside the laboratory in the background.

Chemical Engineer Neil Wilson runs a water titration test in the chemical laboratory. The facilities in this laboratory have multitudes of uses in the study of pipe line problems.

tested, and one of these is now being applied on a pipe line.

The laboratory differs from many others in the stress it places on practical pipe line research. One project is bent on determining causes of mechanical seal failures on centrifugal pumps and the lessons that can be learned from visual observation of these failures. Another is directed at developing a large diameter, high-pressure, control valve that will open or close in a few seconds. One of the most unusual projects is aimed at discovering the best weed and brush killer to apply to pipe line rights-of-way for control of vegetation that impairs aerial patrol.

Intradepartmental Cooperation

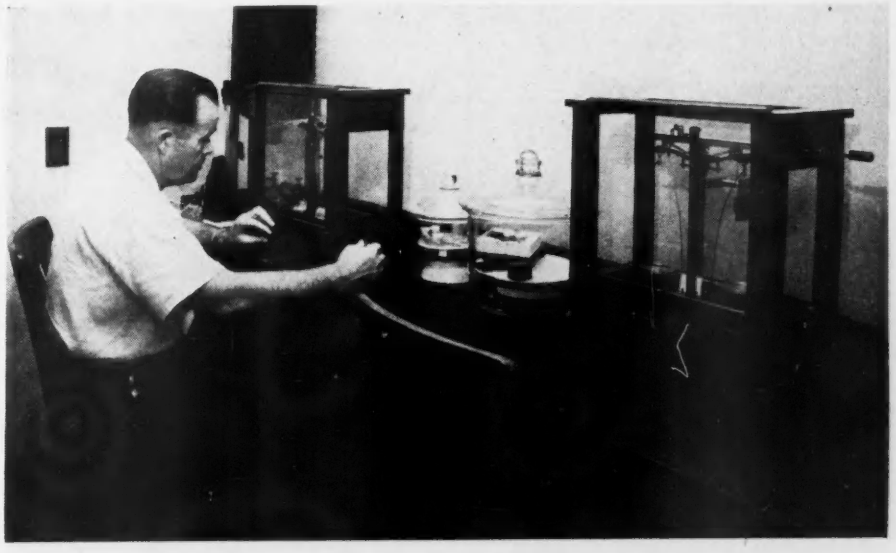
Not all the projects originate within the laboratory. Because it provides a consulting and technical service for the Engineering and Operating departments, much of the laboratory staff's time is devoted to filling requests for information previously accumulated, objectively testing materials, and studying operating problems. This work is carried on with the department that made the request. Other projects may originate with a suggestion from anyone within the company. Insofar as possible, all ideas that stem from employes' ideas are carried on cooperatively with the employe.

This collaboration between field and laboratory has resulted in a number of ingenious developments. One of these, apparently of commercial value, will be patented and possibly licensed to a manufacturer. Other devices initiated in the field and fabricated in the laboratory include a simple mercoid switch tester and a novel means of repressuring pulsation dampeners with carbon monoxide from the exhaust of a truck.

One of the most important phases of the laboratory's work is the testing of hundreds of pipe coatings. Even pipe coating manufacturers would find enlightenment about their own product in this extraordinary laboratory. For here they would find their own product, along with hundreds of competitive ones, being broken down under merciless scientific tests that accomplish in a matter of days what nature would perform in a matter of years in moisture penetration and electrical resistance breakdown.

These tests, which show the earth's long range effects on insulating paints and pipe coatings, are expensive. First a solid magnesium cylinder about three inches in diameter and eight inches long is precision cut in the

The mechanical seal tester in which prototypes of seals are tested before being installed on Shell's centrifugal pumps in crude oil service. Adin H. Hall, who carries on this work, is placing a seal face in its housing prior to testing. The building in the background is the laboratory warehouse.



C. H. Goodnight, laboratory supervisor, in the Microscope and Balance Room. A photomicrographic camera is in the background. This small room is located over the building foundation to minimize vibration that could affect the sensitive instruments.

The machine shop, under Shop Supervisor Gayle Rodeman, is well equipped for constructing most of the instruments and special devices designed by the staff for either laboratory or field use.

laboratory's machine shop, and coated with the material being tested in strict accordance with manufacturer's directions. Then the cylinder is installed in the crude-soaked, corrosive soil contained in the concrete vats outside the laboratory. The coating is held under the continuous galvanic potential of magnesium-iron, and the amount of current passing through the coating is measured frequently. The increase of current is an index of the deterioration of the coating.

After failure, cylinders are removed from the soil and mounted in a device that permits all surfaces including top and bottom to be photographed at once. (This device, which makes use of a novel arrangement of lights and mirrors to present multiple views to the camera, was designed and made in the laboratory). These photographs, electrical records and opinions resulting from visual inspections become a part of the record of the test.

It is noteworthy that several industrial paints, laying no claim to below-ground insulating properties, have been tested and found to have excellent electrical and moisture penetration resistance.

Manufacturers' Benefits

Often Shell's laboratory developments in the industrial sphere provide valuable assistance to manufacturers—free of charge. For example, in order to facilitate automatic flow control to insure continuous line operation, Shell needed a number of large-diameter, high-pressure control valves that would open or close in a matter of seconds under field conditions. A valve operator that would exactly meet specifications could not be found, and the problem was turned over to the laboratory staff, and an operator modification project was evolved. Starting with the operator that came nearest to meeting the requirements, the staff made new parts, varied conventional functions, and in the end came up with a super-quick opening and closing valve. Although Shell profits by obtaining the needed valve, the manufacturer will benefit by this research.

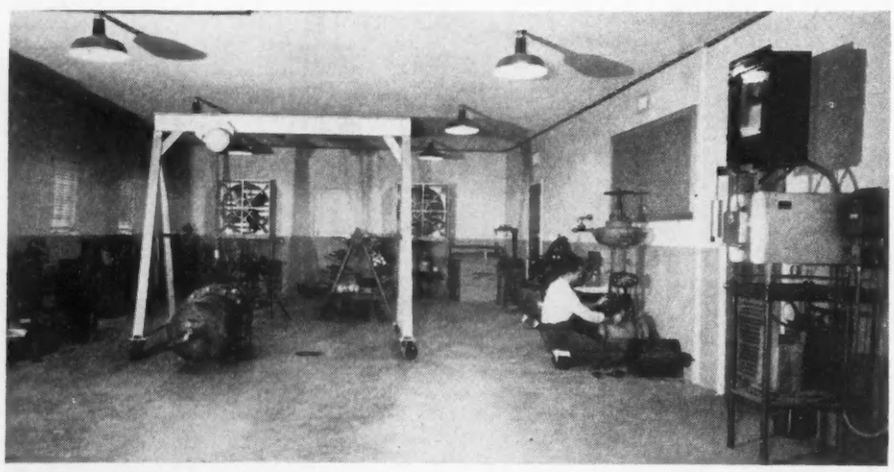
There are other instances of manufacturers indirectly receiving benefits of Shell's research. One such is the project that ended in the adaptation of mechanical seals to centrifugal pumps in crude oil service. Shell performed this work on a cooperative basis with manufacturer. Today work in this field is concerned with finding the causes of seal failure. In this investigation, which is destined to last for several more years, all mechanical seals installed on any of Shell's pipe line pumps are first checked, catalogued, and in some cases re-machined in the laboratory before being installed in the field. When a seal on a pump fails, it is sent back to the laboratory to be inspected. Thus, each seal failure contributes a bit of knowledge to the over-all investigation. As facts emerge, they are passed on to manufacturers to aid them in improving their seals.

Since some of these failures can be traced to improper alignment of pump shafts and other extraneous contributing causes, visual observation, photographs and records must be linked to on the spot field checks of pumps. This information is being catalogued for future operating use.

Other projects completed or near completion are a design for a surge chamber for reciprocating pumps; methods of "in line" blending, or blending oil within tanks; design of high-speed pressure control system for pump station operation; and the design of an effective settling tank for removing abrasive solids from a flowing stream.

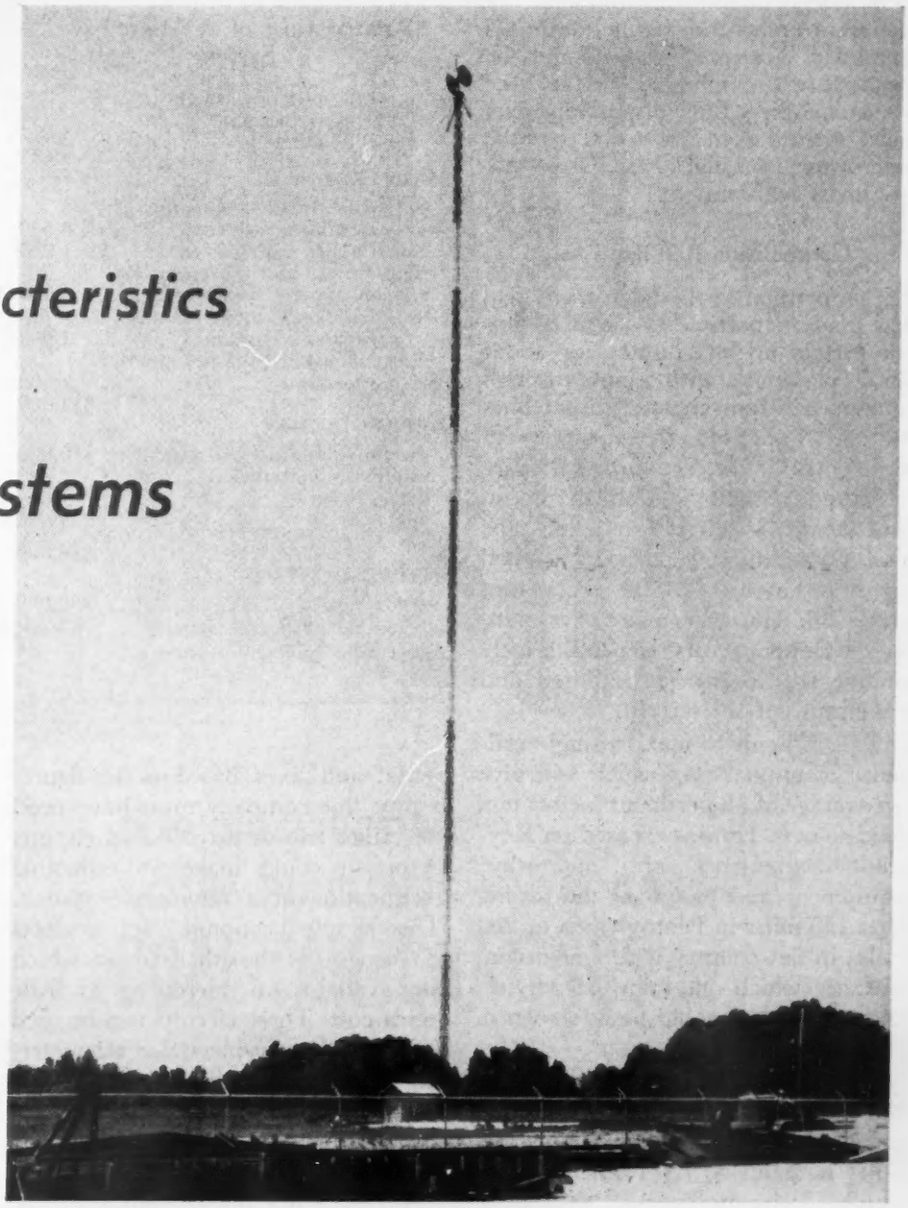
It is certain that many more worthwhile developments will come out of this laboratory. The refining, the drilling and exploration branches of the petroleum industry have proven that research will pay rich dividends. It is reasonable that research in the pipe line industry, too, will pay dividends, especially when it is receiving the energetic support given this project by Shell Pipe Line Company's top management.

The darkroom, with complete facilities for any industrial photographic job, is operated by utility man John Bergeron. The furniture in this room was designed to fill the specific needs of the laboratory.



The mechanical laboratory is constructed so that medium sized pumps, motors and engines can be installed for test purposes. Special control valve equipment is being tested by Mechanical Engineer Rea H. Putnam.

Cost and Operating Characteristics of Microwave Systems



By E. B. DUNN

Communications Engineer
The Atlantic Refining Company
Philadelphia

IN NOVEMBER, 1949, Keystone Pipe Line Company put into commercial operation the first microwave communications system employed in pipe line use. (See WORLD OIL, March, 1950.) This system was about 70 miles long. Today there are 10,778 miles of microwave systems either in operation or under contract.

Many other companies, not yet equipped with microwave, are inquiring into cost and performance data on this system. Their principal questions are: How much does equipment cost? How much does it cost to operate and maintain? How dependable is it? What percent of the time is it inoperable due to maintenance shutdown or fading? Some of these questions can now be answered.

The equipment offered for pipe line use is designed to handle from five to 24 channels. Once the basic equipment is installed with a few channels, additional circuits can be added very cheaply up to the design limit of the equipment. The cost is about $700 per channel.

Audio Quality

The audio quality of microwave circuits is equal to or better than anything ever offered by wire lines. Audio band width may be whatever is desired, but is generally designed for 200 to 3400 cycle telephone service. Channel noise in Keystone's equipment is usually 50 decibels below one milliwatt (flat weighting), and is not

GROWING INTEREST in microwave communications was greatly accelerated by the severe ice storms of the past two winters, when pipe line communications were almost non-existent. Many companies totally dependent on poles and wires for communications found cause to envy those with microwave equipment, and thereafter began inquiry into microwave operating costs. The author here discusses the trend toward microwave use and installation and operating costs, and details the dependability of the method. This paper is from a talk given before the Southern Gas Association at Biloxi, Miss., April 23.

apparent unless the channel output is amplified. Transmission losses may be completely eliminated; in fact, the Keystone Pipe Line dispatching circuits operate from end to end over the microwave at a slight gain. Cross-talk is almost non-existent.

Competition Reduces Costs

Competition in the microwave field has made it possible to install a simple system in flat country for about $600 per mile with eight through channels. A four-channel dispatching system through rough country, with drops every 30 miles, and with spare or standby radio equipment would cost about $1200 per mile of pipe line. For estimating purposes, a good figure to use is $20,000 per microwave link. However, microwave costs, like telephone costs, depend largely on the type of service required and the nature of the terrain.

It is difficult to make a single estimate of annual cost which will give an average of all pertinent factors in a field so new. However, based on Keystone's experience with microwave equipment and based on the feeling that 150 miles in Pennsylvania or 200 miles in flat country is the maximum distance which one man can service, these estimates would be as shown in the table.

Another products pipe line firm in the Pennsylvania area reported that its annual cost of leased telephone circuits is about $75 per line mile including circuit rental, equipment rental, and taxes. Based on this figure, a pipe line company must have need for either two or three leased circuits before it could make an economic justification of a microwave system. This simple economic fact neglects the benefits of the other circuits which are available on microwave at little extra cost. These circuits can be used for pipe line business, for telemetering and remote control, and for the control of mobile radio base stations. In addition, there is a real advantage in microwave reliability and in the fact that a microwave system can be independent of outside maintenance effort.

Annual Cost of A Microwave System

150 miles in rough terrain
or
200 miles in flat country

MAINTENANCE	
Salary and travel expense of one maintenance man	$ 6,500
Small tubes (annual change)	1,000
Transmitter and power supply tubes (twice yearly)	3,000
Building and tower maintenance, spare parts	1,000
Electric power ($25 per month per location)	2,500
	$14,000
DEPRECIATION	
Radio equipment (10 year life)	$10,000
Buildings and towers (20 year life)	5,000
Taxes	1,000
	$16,000
TOTAL COST	
Per year	$30,000
Per mile (150 mile system)	200
Per mile (200 mile system)	150

Radio Spectrum

The microwave radio spectrum is a loosely defined band of radio frequencies extending from about 1000 mc (wavelength: 30 centimeters) to about 30,000 mc (wavelength: one cm). The curves of Figure 1 show some of the characteristics of these frequencies. Since the antennas used increase in effectiveness with increasing frequency, the received signal might ordinarily be expected to increase with increasing frequency, all other factors being held constant (Curve A). However, normal weather conditions seriously affect the microwave frequencies above 7000 mc (Curves C and D). A 10,000 mc radar can be completely blanked out by a tropical cloudburst; a 30,000 mc radar is limited to a few miles effective range by a water vapor absorption. A sidelight is the fact that these highest frequencies are useful in the laboratory for microwave spectroscopy of gases.

From the curves of Figure 1 it can be seen that the microwave spectrum in the neighborhood of 5000 mc would be the ideal spot for microwave communications, but this band is reserved for government use. Pipe line communications fall into two bands, 2000 mc, and 6700 mc. The increased antenna efficiency of the higher band is partially offset by the higher power

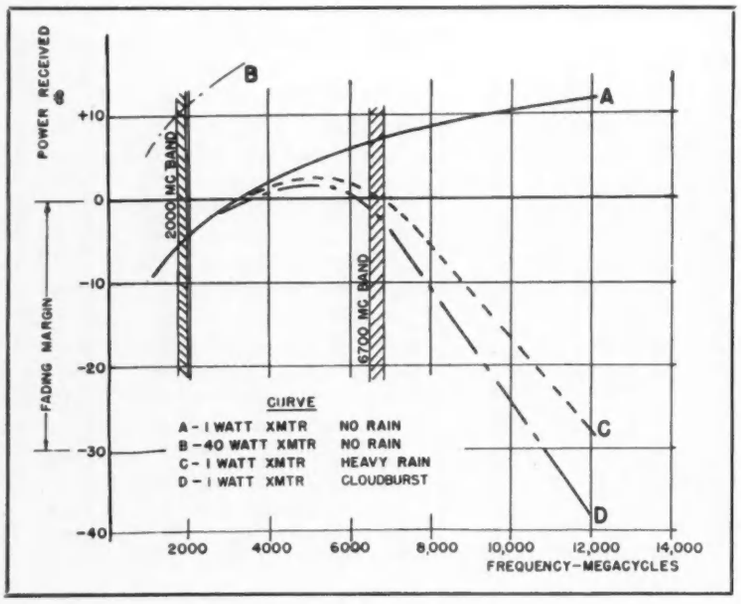


FIGURE 1. Effect of weather on microwave circuits (assuming constant transmitter power and antenna size).

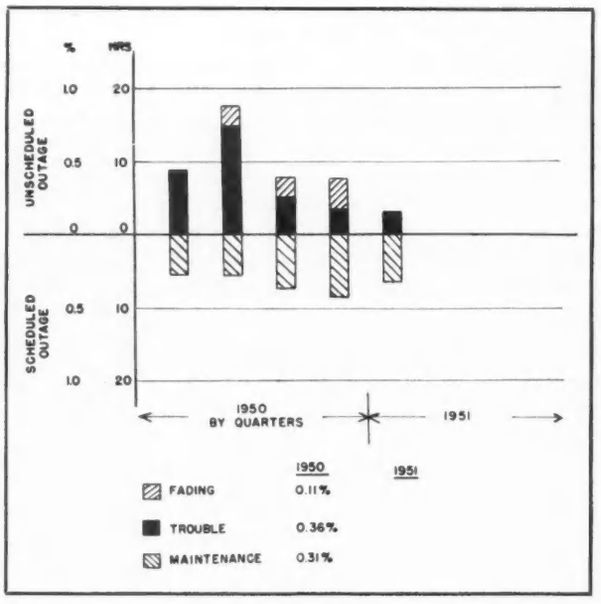


FIGURE 2. Keystone Pipe Line Company microwave outage time (0.1 percent equals 45 minutes per month).

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2. **Barrett makes coal-tar enamels** in grades that will not crack at —20°F., nor flow at 160°F.
3. **BARRETT coal-tar enamels** possess high ductility and flexibility in all grades, and show high resistance to soil stresses.
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of lower band transmitters. (Curve B).

Service on the Keystone microwave system is completely unaffected by storm, ice, rain, fog, snow, static, or magnetic storm. When the east coast "hurricane" hit in November, 1950, the microwave system alone rode through the storm without trouble. Wire lines have been out of service for a week or two at a time following a Pennsylvania ice storm, but the microwave has gone through ice storms without faltering.

Atmospheric Fading

The one weather effect which prevents perfection is the phenomenon known as atmospheric fading which is experienced during the summer and early autumn months. This fading is a result of beam bending which, in turn, is caused by "stratification" of the moisture vapor content of the air immediately above the ground. This might be the result of a weather front which moves warm, dry air in over moist air to produce a gradual fade resulting from down-bending of the beam. This same phenomenon causes unusually long distance reception of television, FM, mobile radio, and radar, since it often causes the beam to follow the curvature of the earth. The second type of fade is a result of the opposite conditions, dry air under moist air. This usually occurs on a clear, still night following a humid day when the earth's heat is rapidly lost by radiation, and the moisture vapor is absorbed out of the lower atmosphere by the cool earth to form heavy dew or patches of ground fog. The resulting upbending of the beam cuts off the signal suddenly and completely.

There is little a radio engineer can do about atmospheric fading. He can build a large margin of safety into the equipment, perhaps 30 db, or 1000 times the power normaly needed, and this will reduce the fading outage time to something on the order of 0.05 percent or about five hours per year, per hop according to Keystone experience. Shorter hops and higher towers will help, but these are not usually economical.

Time Factor

The one saving factor is that atmospheric fading usually occurs in the small hours of the night, from 11 p.m. until 4 a.m., a time when circuits are lightly loaded, and when long distance calls go through with little delay.

All of the factors which affect the performance of the Keystone microwave have been combined in the outage time record shown in Figure 2. The atmospheric fading outage totaled 9.6 hours for 1950, and all trouble outage added up to 31.8 hours for the year. This was largely due to tube failure. More than 50 percent was due to failure of the 2C43 transmitter tubes. The large outage time in the second quarter represents our difficulties with the first 2C43's of post-war manufacture. During this period the average life on these tubes was only two months. However, experience has enabled Keystone to detect failures in advance, and the average life has recently been raised to about five or six months by the simple expedient of raising the filament voltage slightly.

Value of Standby Equipment

The Keystone system has no spare equipment, and the majority of KPL's trouble outage could have been eliminated by standby RF equipment. Likewise, standby equipment would have prevented the scheduled outage time required for all tube changes and maintenance. In a long microwave system for cumulative effect of maintenance outage would in itself justify standby.

Keystone's pulse time modulation multiplex equipment has been most reliable. Since December, 1949, Keystone has had no multiplex trouble which caused a loss of all circuits, and only two isolated cases of tube failure in an individual channel.

Maintenance

It is Keystone's custom to make a weekly check of each unattended repeater, but this could easily be extended to two-week intervals, and perhaps even to monthly intervals. The equipment is stable in RF frequency and in multiplex operation. Maintenance is greatly facilitated by using the oscilloscope to make visual checks of all circuits. Trouble outage time has largely been the time required to locate the maintenance man and get him to the source of trouble. It has averaged about two to three hours per outage. Speedy fault location would be greatly facilitated by a system of fault tones of fault alarms, and such a system of fault location would become a must on a longer microwave system which did not have standby RF.

The Keystone experiment in microwave has been completely successful, and its performance has exceeded both requirements and expectations. The best evidence of this success is the manner in which microwave has been accepted by many pipe lines.

About the Author

E. B. DUNN was an electrical engineering graduate of the University of Virginia in 1939, and before World War II was employed by the Switchgear Engineering department of Westinghouse Electric Company, East Pittsburgh, Penn. During the war he received specialized training in electronics, microwave, and radar at the Navy Schools at Harvard and M. I. T., and served three years as electronics maintenance officer with the Navy Air Force. Since 1946 he has been electronics engineer for the Communications department of The Atlantic Refining Company, Philadelphia, specializing in radar and microwave equipment. In this capacity he has been responsible for the technical phases of the installation and operations of the Keystone Pipe Line Company's microwave system from Philadelphia to Montello, Penn.

Pipe Line Microwave Systems
May 1, 1951

PIPE LINE	Length	Channel	Completion
Humble	400	8	....
El Paso Natural Gas	500	2	....
Great Lakes	80	2	....
Platt	1000	5	1952
Southern Counties Gas	58	..	1950
Texas Gas Transmission	70	..	1950
Mid-Valley	1000	..	1951
Pan American	150	..	1950
Panhandle Eastern	350	..	Sept. '51
Shell	150	..	1950
Texas Illinois	1000	..	Sept. '51
Transcontinental Gas	1840	..	1951
Keystone	70	6	1949
Trunk Line Gas	1300	6	Oct. '51
Texas Eastern	1400	8	Jan. '52
Michigan-Wisconsin	1400	8	Jan. '52
Total, Miles	10,778	..	....

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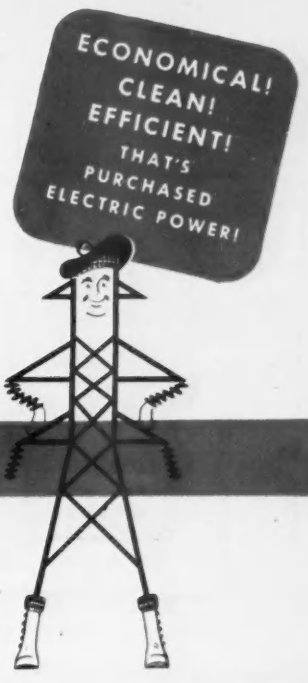

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By R. H. DALE
Cooper-Bessemer Corporation

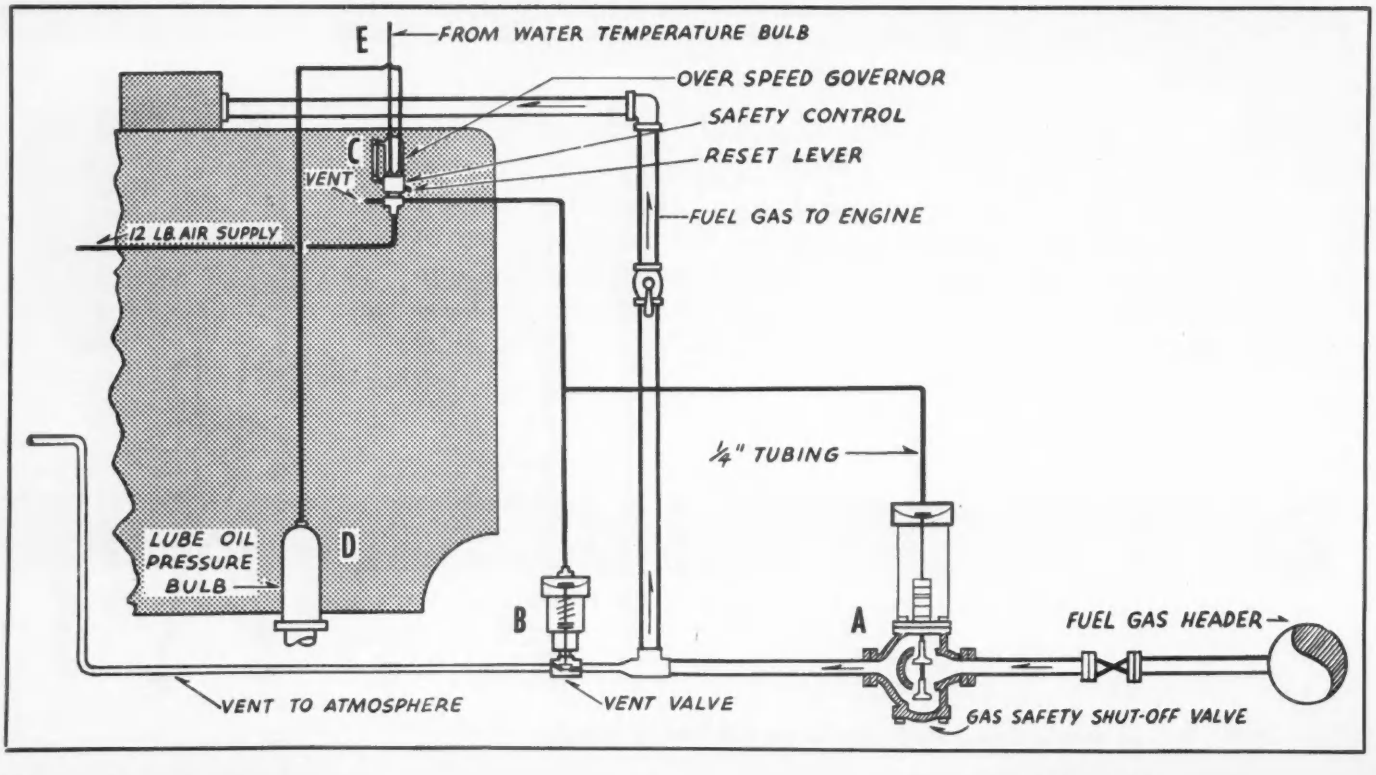
AN AUTOMATIC shutdown control has been developed which will shut off the fuel and halt gas-operated compressor or pump station engines in case of overspeed, low oil pressure and high water temperature. At the same time it automatically vents any fuel gas that might escape past valves and accumulate in the engine during idle periods. This eliminates one serious hazard to engine operation. This system is shown in the accompanying schematic drawing. The mechanical switch at "C" actuates a three-way valve located just below the case which controls the 12-pound pilot air that operates the control valves A and B.

Starting Engine

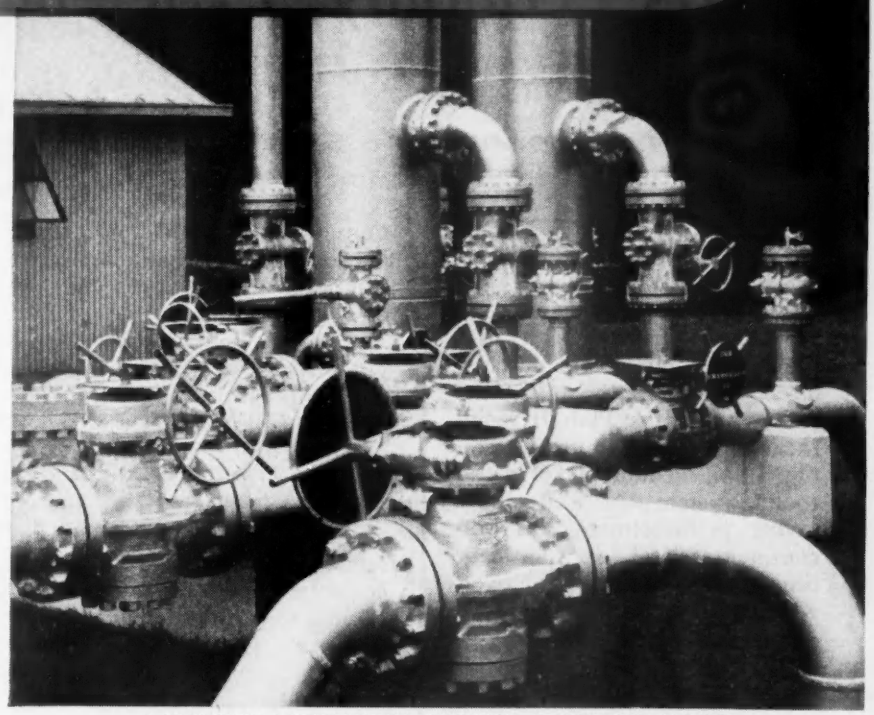
To start or operate the engine, the control valve at C must be open to admit pilot air to the pressure diaphragms of Valves A and B. This pressure causes Fuel Gas Safety Shut Off Valve A to open and Vent Valve B to close, thus admitting fuel to the engine and closing the vent system. In case the shutdown control trips, the three-way valve vents the pilot air from the diaphragms of these two valves, causing them to reverse their action, shutting off fuel gas to the engine at A and venting any escape gas at B.

The shutdown control has a pressure element, D, connected to the inlet of the lubricating oil header and shuts the engine down in case the oil pressure drops below a safe level. As there is no oil pressure available at starting, the device is placed in operating position by pressing down on the reset lever. Once the engine has started, the control air will hold the valves in operating position.

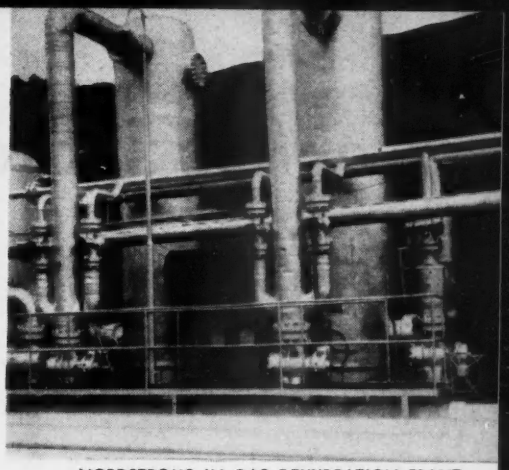
A temperature actuated element, E, in the water system will also trip the safety control switch at C, as will the overspeed mechanical governor.



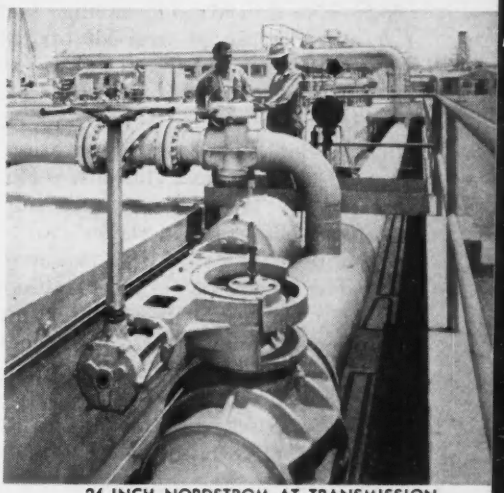
. . in gas line safety



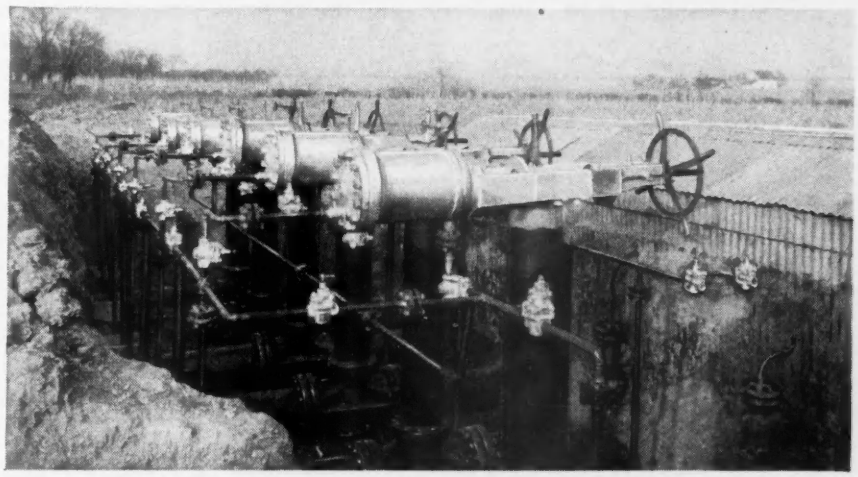
A MEASURING STATION IN PENNSYLVANIA, NORDSTROM-EQUIPPED



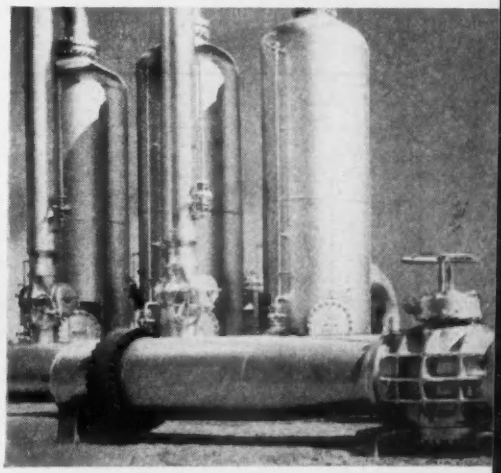
NORDSTROMS IN GAS DEHYDRATION PLANT



26-INCH NORDSTROM AT TRANSMISSION LINE TERMINUS



AUTOMATIC CYLINDER OPERATED VALVES ON GAS TRANSMISSION LINES



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AUTOMATICALLY OPERATED FOR GAS LINE EMERGENCY PROTECTION

Cooling Water Design Adds Economy, Efficiency

By R. D. RICKETTS

Vice President, Fish Engineering Corporation

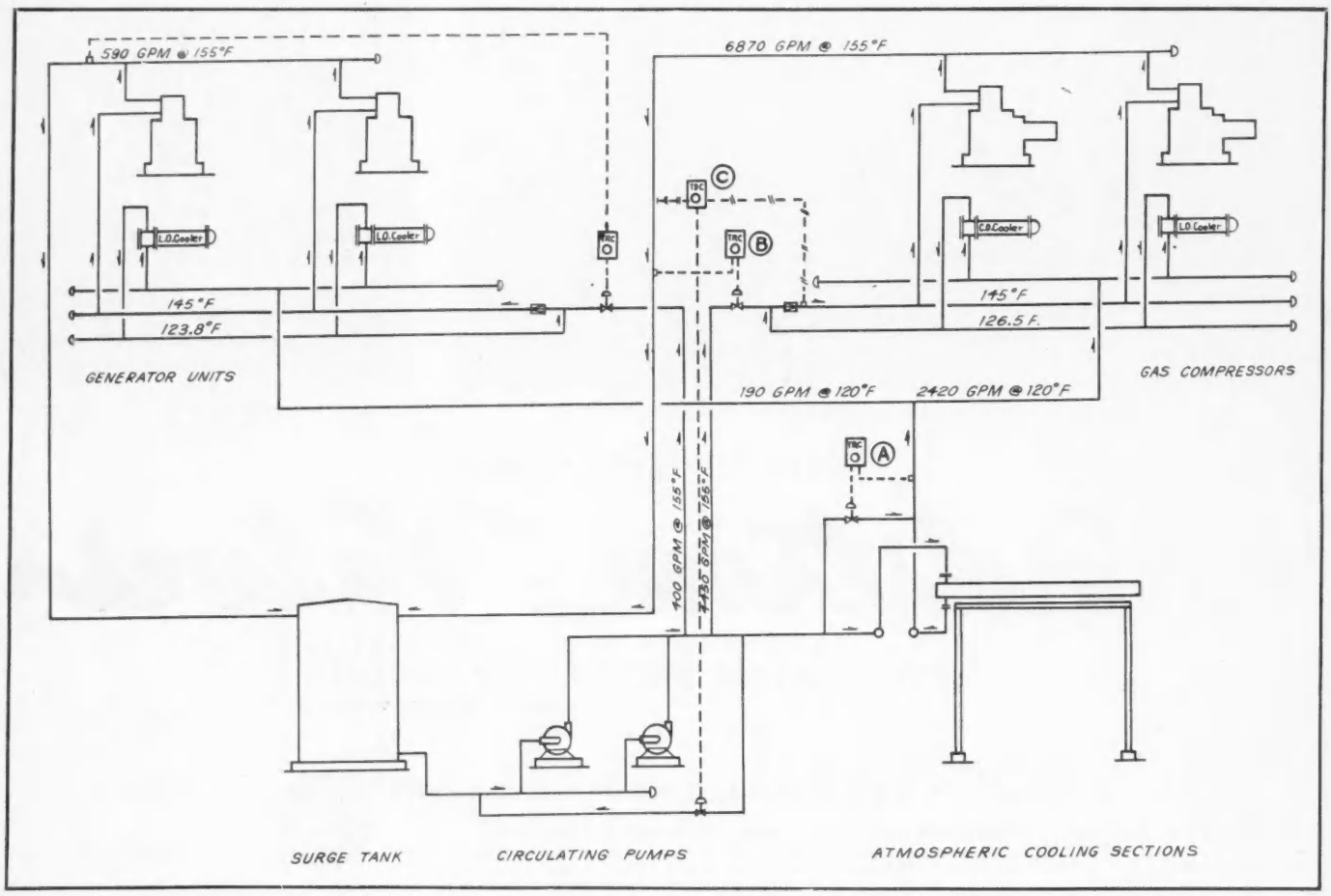
AN INVESTMENT savings and an increase in over-all operating efficiency was effected by Fish Engineering Corporation's revision of cooling water design for Transcontinental Gas Pipe Line Corporation's Plan II compressor stations. (Plan II refers to Transcontinental's huge expansion program designed to almost double its daily delivery capacity.) The necessity for this revision arose out of the scarity of water suitable for use in engine jackets of compressor and auxiliary engines.

Fish engineers found that at some of the proposed compressor station sites there was no underground or surface water available; at other stations was of such poor quality that the treatment necessary to prepare it for cooling tower use would not only increase later operating expense, but would in some cases require a considerable cost to install. Various means of reducing water consumption in the proposed stations were then considered.

THIS ARTICLE supplements one in May WORLD OIL describing Transcontinental Gas Pipe Line Corporations Plan I compressor station lube oil cooling system. Here, the author describes the entire Plan II reciprocating engine compressor stations lube oil and jacket water cooling system which effected a savings in investment to Transcontinental and at the same time slightly increased the over-all operating efficiency.

Atmospheric cooling sections provided the answer. A review of ambient temperatures along the Gulf and Atlantic Coastal Plains indicated that a satisfactory mean temperature differential (MTD) existed between ambient air and the water to be cooled, and therefore, the atmospheric sections were feasible. Their expense could be balanced against the cost of cooling towers, cooling sections, water wells, and water treating equipment.

Design problems then were resolved to providing the utmost in flexibility and efficiency of operation. Since all of the new reciprocating compressor



Flow diagram of Transcontinental's Plan II, 12,000-horsepower reciprocating compressor station cooling water system.

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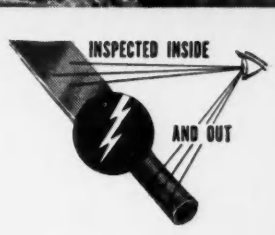

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stations were to be equipped with 1600 or 2400 horsepower engines, even one of these units in or out of operation would affect the amount of cooling water needed to maintain correct jacket water temperature. Inasmuch as power requirements at compressor stations can vary from 2400 to 12,000 in a matter of minutes, and since ambient temperatures likewise can vary greatly, a cooling system that would more or less automatically adjust itself to these variable conditions had to be devised. The resulting design is illustrated on the accompanying flow sheet.

The systems discussed here are limited to those applicable to reciprocating engines which are either 1600 or 2400 horsepower units. The cooling water systems for both will be discussed simultaneously, since the basic design is quite similar. The total station horsepower is either 12,000, consisting of five 2400 hp units, or 11,200, consisting of seven 1600 hp units. However, quantities and temperatures of water described here and on the flow sheet refer to the 12,000 hp stations.

A single cooling system was installed to service the lube oil coolers and engine jackets of compressor engines as well as auxiliary engines. No compressor cylinder jacket cooling was necessary.

Each of these stations is equipped with three 3850-gallons-per-minute water circulating pumps—two operating and one standby. These pumps supply the total circulation rate for both auxiliary and compressor units, which are designed for full load continuous operation.

As shown in the flow diagram, the jacket water leaves the engines at 155° F. The water enters a common return header mounted on the main building columns and flows directly to the jacket water surge tank, which is adjacent to the auxiliary building. The jacket water surge tank serves as a reservoir for the circulating water pump intake. Then the water is pumped to the atmospheric cooling sections approximately midway between the auxiliary building and compressor building.

Stream Temperature

A temperature recording controller, A, bypasses sufficient 155° F. water around the jacket water coolers into the outlet stream to control the combined stream temperature at 120° F.

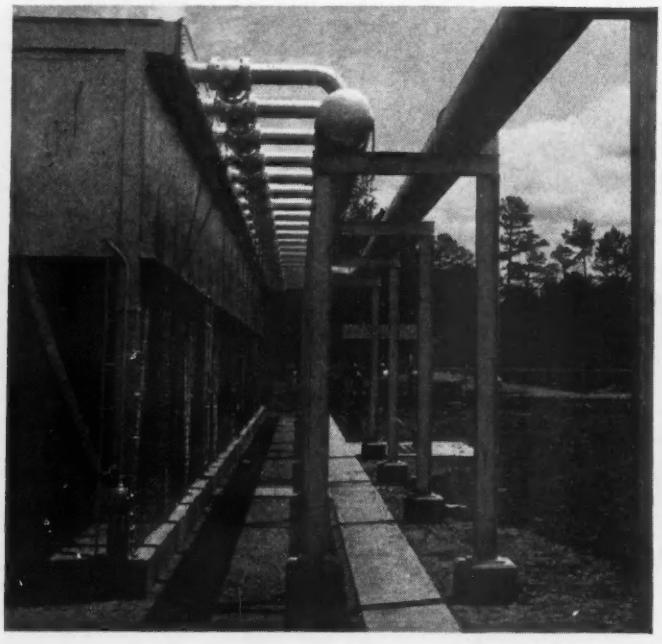
Auxiliary and compressor engine lube oil cooling requires 2610 gallons per minute of 120° F. water. This water enters the lube oil coolers at 120° F. and leaves the compressor engine oil coolers at 126.5° F. and the auxiliary engine oil coolers at 123.8° F. Of this water, 2420 gpm are required for the main engine lube oil cooling and 190 gpm are required for auxiliary engine lube oil cooling.

The water from the compressor engine lube oil coolers is returned to a common header in the basement and blended into the main stream of 4450 gpm of 155° F. water flowing to the compressor engine jackets. This gives a combined stream of 6870 gpm at 145° F. for compressor engine jacket cooling service. The temperature of the water is increased 10° F. in passing through the engine jackets. Water returns to the surge tanks from the engines.

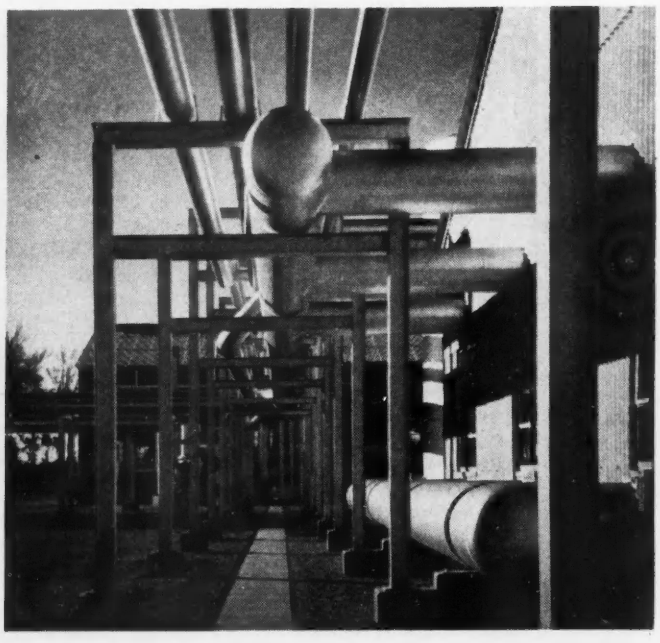
A temperature recorder-controller, B, installed just ahead of the point of junction of water off the lube oil coolers and the main stream to the compressor engine jackets permits sufficient 155° F. water to blend with the lube oil cooling water to maintain a predetermined engine jacket water outlet temperature.

A temperature differential controller, C, installed on the system permits back flow to the pump suction. This instrument provides adequate temperature and water pressure control when the plant is operating at reduced capacity.

As indicated in the flow diagram, 190 gpm of 120° F. water is taken from the system and piped directly to the intake of the auxiliary engine lube oil coolers. The temperature across the lube oil coolers is increased 3.8° F., resulting in a water outlet temperature of 123.8° F. This stream of 190 gpm of water at 123.8° F. is blended with auxiliary engine jacket water cooling stream of 400 gpm 155° F. water. The outlet temperature of the auxiliary engine jacket water is controlled at a predetermined value by a temperature recorder controller, taking its temperature from the outlet header and controlling the quantity of 155° F. water going to the auxiliary engines. The high temperature outlet water is returned directly to the jacket water surge tank for recirculation.



Atmospheric sections used in cooling jacket and lube oil cooling water at Transcontinental's Station 8, near Laurel, Miss.



Cooling water piping installed on overhead pipe racks along with fuel gas and air piping insures easy maintenance.

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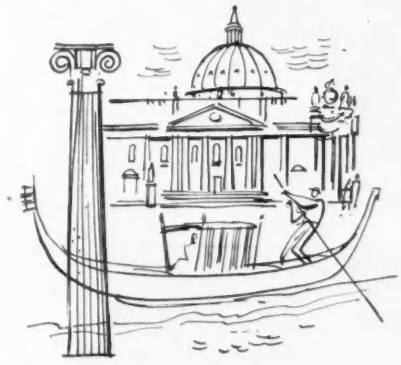

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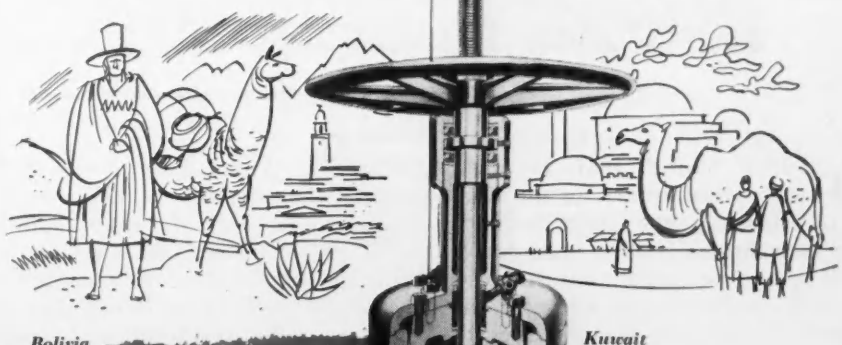

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COLLAPSIBLE STORAGE TANK

Collapsible tank of 10,000-gallon capacity.

DURING World War II there was a constant cry for the storage of petroleum products in the field. The conventional bolted steel tanks used by the petroleum industry did and will continue to do a job for the Armed Forces but it takes days to erect them, and in the case of the larger tanks, weeks.

It was because of the time required to install even the smallest bolted steel tanks and the difficulties encountered when the drums were floated ashore that the Engineer Research and Development Laboratories at Fort Belvoir, Va., continued the effort and produced a 10,000-gallon collapsible container. In forward areas, at truck fill stands, along the pipe line at pumping stations and in landing operations, they can be filled by pipe line or hose line from small barges and tankers.

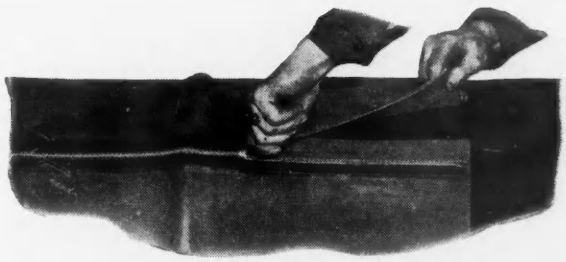
Some collapsible containers were tried during World War II with little success. The designs in all cases required some form of support which took time to install and could not be done by untrained troops. One of the major difficulties was caused by the creasing of the container in storage. A container that has to be folded with double folds causing constant strain in storage is apt to leak when placed in use. Various shapes of containers were suggested and tried but all with the exception of the spheroidal container had to be supported by one method or another with supports such as wood panels or earthen dyke. The spheroidal container was self supporting but creased in storage and proved difficult to make and its shape did not lend itself to autoclaves so that it could be vulcanized into single units.

The qualities desired for the collapsible tank were that it would be simple to make, capable of being vulcanized into a single unit, easy to carry, not damaged in storage by creasing, capable of being installed quickly by troops in the field with a minimum of training.

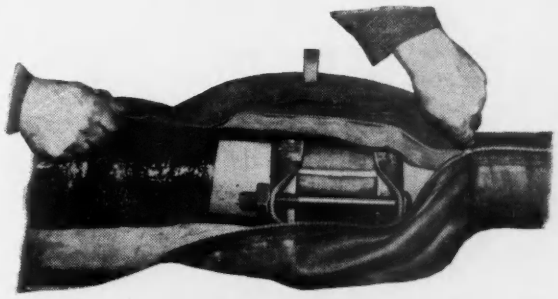
The "pillow" container is made of Buna N synthetic rubber reinforced with inner and outer layer of nylon cloth all formed into a 3/32 inch thick sheet. The inner layer of nylon cloth has an adhesive coat, a liquid coating of nylon to serve as a barrier to prevent porosity, and a layer of Buna N which is in contact with the liquid contained.

The heavier outer layer of nylon cloth is impregnated with the adhesive coating and Buna N in the same manner as the inner layer but without the nylon barrier. The thin coating of liquid nylon (.0002th) greatly reduces the loss of gasoline by permeation. This thin coat of nylon

Now—you simply "pull the zipper" on corrosion problems



Dresser ZIPCOAT for welded joints zips over weld area, fits closely to the pipe. 30″ lengths.



Dresser ZIPCOAT for couplings is easy to install over joint and pipe ends—all in one quick operation. Has bleeder valve to vent air during backfilling.

NEW DRESSER ZIPCOATS* GIVE SURE PROTECTION, SUPERLATIVE DIELECTRIC STRENGTH

"As easy as zipping up a jacket" is what workmen say about Dresser's new ZIPCOATS. They install ZIPCOATS in 1/10 of the time it takes to coat a joint. You get protection that equals or exceeds that offered by the mill or yard-wrapped pipe.

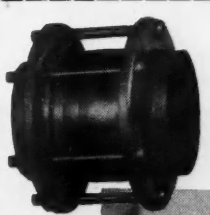
And look at the hazards you avoid: there's no flame; no heating, hauling or messy application of hot stuff; no danger from fumes or burns.

Can be installed in any weather.

Write today for descriptive material and price list.

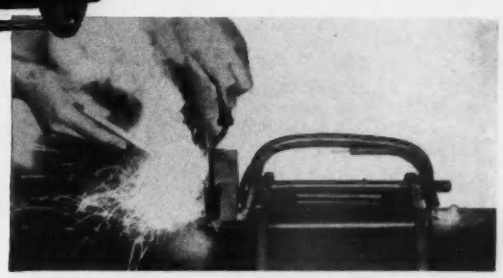
*Every ZIPCOAT complete with anaerobic microbiological corrosion inhibitor and cold sealing compound. ZIPCOAT is a trade mark of Dresser Manufacturing Division.

Dresser ZIPCOAT for insulating joints is made like the ZIPCOAT for welds, but in ten-foot lengths. Installing one on each side of an insulating joint that's protected with a ZIPCOAT for couplings gives ultimate protection. Eliminates costly boxing and filling with dope. Immediate trench backfill saves time.



Install Dresser Insulating Couplings **IN MINUTES**

Dresser Style 39 Insulating Couplings with new plastic gaskets insulate effectively and are the simplest insulating type joint to install. Sizes ¾″ to 30″ and up.



New Dresser Bonding Method saves up to 50% of cost; materials preformed

Fast bonding, giving low resistance with *pre*formed Dresser Bond and 5-second chemical welding method. Needs no special skill, no bulky equipment. Makes homogeneous weld area, eliminates surface contact variables. Compact kit of 50 *pre*formed bonds includes all materials needed for installing.

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Collapsible storage tank under Arctic tests.

is equivalent to 1¼ inches of Buna N in ability to stop this detrimental effect. The number of openings into the container have been kept to a minimum since all openings are possible trouble sources. The small opening center top is not a vent but an overflow to be sure no one forgets to stop filling the container. The single four-inch opening on the end fitted with a flexible hose is the inlet and outlet to the container. The valve is placed at the end of this flexible connection.

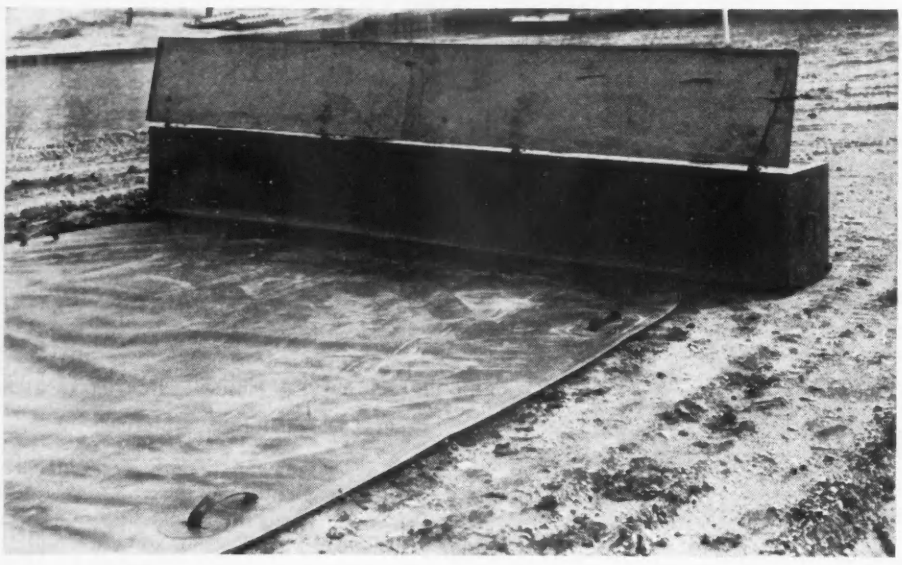
Pump Unit

A self-priming transfer pumping unit designed at ERDL has proved suitable for use with the container. The container can be emptied by gravity where the terrain permits.

The difficulties of preventing strain on the container plus the trouble of tightening the flange bolts in case of seepage, especially with water in ground clearance holes, makes the connection at the top more desirable than one at the bottom.

The comparatively heavy sheet material used for the entire container safeguards the top from sharp objects which may be dropped on the low container, and also protects the bottom which rests on the ground. One container has been in use at the Petroleum Distribution Branch Test Area for more than 18 months, with no damage from sharp objects or rough terrain.

Tests have been made on the fabric and on the container as shipped. The tests on the fabric using SR 6, the 40 percent aromatic test fluid, indicate that .021 ounces of gasoline will pass through one square foot of fabric in 24 hours at 75° F. Tests on the container at Fort Belvoir, Va., were made by filling the container with 91 octane gasoline and checking for leaks. After a period of 30 days the container had several small "wetted" areas but these soon disappeared. The duration of this test was 12 months. The second container test at Fort Belvoir was made by leaving the container in its protective carrying box for a year and then filling it with gasoline to see if the time in storage damaged the fabric. It was found that one year's storage does not damage this container. Tests of the container at Fort Churchill, Manitoba, Canada, through the winter of 1948-49 indicated the container could be used at —45° F. if necessary. The container was partially emptied at —30° F. and although there was some slight wetting of the surface the container appeared to be suitable. A test was made to determine suitability if some gasoline was kept in container at all times. Although the test did not include use when empty, it is believed that the container could be handled at —45° F. when dry.



Protective box for collapsible storage tank.

Capacity Tests

One test was made to determine amount of water that could be safely pumped into the container before danger of breaking. It was found that 12,000 gallons could be held but it was considered not advisable to overload the container. When the test was continued and the container was filled to one and a half times normal capacity, or 15,000 gallons, the container burst.

The container is quickly installed by unrolling it like a rug from the protective box. The only requirement for installation is a flat site which is free of sharp objects. The outer and end connections are quickly bolted into place and the container is ready for service.

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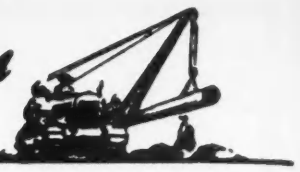

By CECIL W. SMITH, WORLD OIL Staff

Projects Announced and Contracts Awarded

Crude Oil Lines

Service Pipe Line Company plans to build 135 miles of 8 and 10-inch line from Old Glory field, Stonewall County, West Texas, to the Company's system at Bowie.

Service Pipe Line Company has asked for bids for the laying of 7¾ miles of 4 and 6-inch pipe to provide an outlet for the northern part of Sage Spring Creek field, Natrona County, Wyoming. Service's own crews will soon start to lay 6¾ miles of 2, 4, and 6-inch line from the Meadow Creek field, southern Johnson County.

Shell Pipe Line Corporation intends to lay an 8-inch pipe line to give outlets to Gohlke and other fields in DeWitt County, Texas Gulf Coast, by connecting them with Shell's Houston refinery.

The Toronto Pipe Line Company is planning to build a pipe line from the Yenter field, Logan County, Colorado, extending northward through other producing areas of the Denver-Julesburg Basin to Service's main line running from Wyoming eastward.

Products Lines

Buckeye Pipe Line Company's stockholders have approved a plan to build 430 miles of common carrier pipe line between refining areas adjacent to New York and Philadelphia and consuming areas in eastern Pennsylvania and Central New York. The plan calls for 75 miles of 14-inch from Linden, N. J. to Allentown, Penna.; 55 miles of 8-inch from Marcus Hook, N. J., to Allentown; 235 miles of 12-inch from Allentown to Oswego, N. Y.; and 65 miles of 8-inch from Auburn to Rochester, N. Y. Pipe laying will begin in 1952.

Compagne Petroles Francaise will lay 200 miles of 10-inch pipe from LeHarve to Paris, France. Entrepose, an affiliate of Societe Francaise de Constructiones, will do the job and will start in several months.

Natural Gas Lines

Atlantic Seaboard Corporation has applied to FPC for authority to construct a 3520-hp compressor station in Randolph County, W. Va., and its Cobb-Rockville 26-inch line.

Canadian Montana Gas Company will build a 66-mile line from the Pakowki gas area in southern Alberta, Canada, to the Cut Bank field, Montana. This line will carry to Montana Power Company the first gas exported from Alberta. Construction will probably start in June.

Central Kentucky Natural Gas Company has applied to FPC for permission to build 19 miles of 12-inch main line loops between Winchester and Lexington, Ky. That would complete the looping of its 10-inch Menifee to Lexington line.

Cities Service Gas Company has received FPC authorization to build 56 miles of 3, 10, and 16-inch pipe line in Sedgwick, Harvey, and Labette Counties, Kansas. At the same time the company was authorized to abandon 192 miles of 2 to 12-inch line in the same region.

Cities Service Gas Company received FPC permission to install 13,080-hp in new and existing compressor stations. They are: 4800-hp at Hugoton, Grant County and 6400-hp in a new station at Greensburg, both in Kansas, 1200-hp at Welch, Okla., and 680-hp at Pierce City, Mo., both in new stations.

Colorado Interstate Gas Company has petitioned the FPC for authority to build additional facilities on its 216-mile authorized Texas-Colorado main line. If granted, 30 miles of 20-inch loop in Elbert County, Colo. plus a 19-mile 6-inch lateral connecting the proposed main line with Colorado's existing line at Fort Lyon, will be constructed. At a later date 18 miles more will be looped between Kit Carson and Denver and 1320-hp installed at Texas Panhandle field station and 1320-hp added to Kit Carson station.

Kansas-Nebraska Natural Gas Company, Inc. asked FPC for permission to increase its system's capacity by laying 15 miles of 6-inch and 11 miles of 8-inch pipe from Big Springs field, Deuel County, Neb.; 2 miles of 2-inch laterals to Big Springs and Brule; 8 miles of 8-inch and 5 miles of 4-inch from Big Springs field to Ovid, Colo.; 13½ miles of 2-inch and 10½ miles of 3-inch laterals to Chappell, Lodge Pole, Ovid and Julesburg, Colo.; and 52 miles of 8-inch from Ogallala to North Platte, Neb.

New York State Natural Gas Corporation has let contract to Williams Bros. Company, Tulsa, for construction of 77 miles of 20-inch line from South Bend storage pool, Armstrong and Indiana Counties, to the Ohio-Penn state line near Petersburg, Ohio.

Northern Natural Gas Company has let contract, subject to FPC approval of project, for 208½ miles of 26-inch main line loops in Ochiltree County, Texas, Oklahoma, Kansas and Nebraska.

Northwestern Utilities, Ltd. plans to start in June, 6 miles of 6-inch line from Edmonton, Canada, to R. C. A. F. base at Namao and 6 miles of 4-inch from Edmonton to St. Albert.

Panhandle Eastern Pipe Line Company awarded 20 miles of 24-inch and 48 miles of 26-inch loops to R. H. Fulton & Company, Lubbock, Texas. These 5 loops will run between Sneed, Texas, Panhandle and Olpe, Kansas, and will get under way during June.

Southern Natural Gas Company asked FPC for authority to lay a 20-mile supply line in Ouachita Parish, La., 33 miles of main line loop in Ouachita and West Carroll Parishes, a 7-mile loop in Sharkey County, Mississippi, and to substitute 14-inch pipe for 108 miles of 10-inch pipe previously authorized.

Texas Gas Transmission Corporation awarded contract to Mid-States Construction Company, Mount Vernon, Ill., for 12 miles of 10-inch line connecting its main system to its Alford storage field in Indiana, and to lay 4½ miles of 2 through 8-inch storage field lines. Work was started in May.

Texas-Ohio Gas Company, a newly formed firm, is planning to build a 1500-mile 30-inch carrier from the Texas Gulf Coast area to the Central Appalachian Area. The system would have a daily capacity of about 500,000,000 cubic feet of gas and would cost over $170 million. Application to FPC has not been made. This concern will take over certain assets of Valley Gas Line Company, whose application for a Texas-Great Lakes line was dismissed by FPC.

Transcontinental Gas Pipe Line Company let contract to H. C. Price Company, Bartlesville, for 10 miles of 26-inch line from its main line near East Carteret, N. J., across Staten Island and 4 miles of 24-inch pipe across the narrows of Hudson River to the Bay Ridge section of Brooklyn.

United Fuel Gas Company applied to FPC for authority to lay 45 miles of transmission line in Putnam and Kanawha Counties, West Virginia, and to build a 2640-hp compressor station.

United Gas Pipe Line Company received temporary authorization from the FPC to construct 39 miles of 16-inch loop line on its Pensacola lateral in Baldwin and Escambia Counties, Florida, a 5-4/5 mile lateral to Gulf Power Co. in Escambia County, and a 5-mile lateral to Saufley Naval Air Station, Escambia County.

Projects Starting

Crude Oil Lines

Humble Pipe Line Company is having 16 miles of 6 and 8-inch line laid from the Cree-Sykes field, Runnels County, West Texas, to its Fort Chadbourne-Ballinger line, near Hatchel. This job is scheduled to be completed in June.

Pan American Pipe Line Company is having Joe Titsworth Construction Company, Kilgore, Texas, lay 10½ miles of 4, 6, and 8-inch gathering lines in the Forest Hills and Midway Lake fields of Woods County, and Gregg Construction Co. Inc., Longview, construct 10 miles of 8-inch loop on its Quitman-Hawkins line. Both projects were started in May.

Sinclair Pipe Line Company employed Bills & Troth Construction Company, Tulsa, to lay 19 miles 8-inch line between Ringling Station and Rubottom Station, Okla. Contractor started in early May and expects to complete by Mid-June.

Products Lines

Great Lakes Pipe Line Company has 107 miles of 8-inch line underway. A. C. Holder Construction Company, Tulsa, is laying 53 miles from Des Moines to Montezuma, and Geneva Construction

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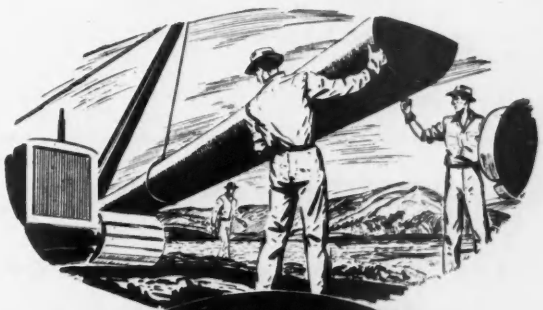

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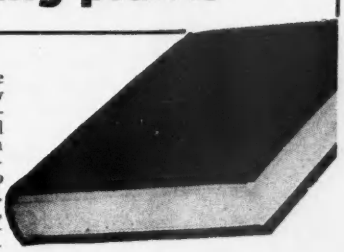

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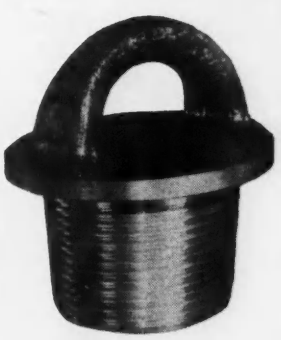

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Company, Aurora, Ill., has 54 miles from Montezuma to Iowa City.

Natural Gas Lines

Hope Natural Gas Company has started 32 miles of 8, 10, and 12-inch line running between Terra Alta gas field to Hope's system near Fairmont, W. Va. The job is being done by Pipeline Construction & Drilling Company, Camp Hill, Pa.

Michigan Consolidated Gas Company has awarded 140 miles of 24-inch between Austin storage field to Detroit to Anderson Bros. Corporation, Houston. Work is scheduled to get underway about the first of June.

New York State Natural Gas Corporation has Pipeline Construction & Drilling Co. laying 15 miles of 20-inch from Preston Station, Greene County to Colvin Gate, and 12 miles of 16-inch from Murrysville Station to Tonklin Station in Pennsylvania.

New York State Natural Gas Corporation employed Williams-Austin Company, Pittsburgh, to lay 37 miles of 20-inch line from Boom storage field to Ithaca, N. Y. This section got underway in May and is part of a 56-mile project to Dryden, N. Y.

Northeastern Gas Transmission Company had Oklahoma Contracting Company, Dallas, start in May 144 miles of 24-inch line between the N. Y.-Mass. border near Pittsfield to Boston Area. This line is part of the 511-mile system being built in Mass., Conn., and New Hampshire.

Ohio Fuel Gas Company is having Somerville Construction Company, Ada, Michigan, lay 20 miles of 20-inch loop between New Albany and Homer, Ohio. Work started in May and is scheduled to be complete by Mid-June.

Panhandle Eastern Pipe Line Company started in May 22 miles of 30-inch near Tuscola, Ill.; 45 miles of 30-inch near Montezuma, Ind.; 63 miles of 30-inch in Zionsville, Ind., vicinity; and 43 miles of 26-inch in the Edgeton, Mich., area. Conyes Construction Corporation, San Pablo, Calif., is doing the construction.

Panhandle Eastern Pipe Line Company awarded contract to Anderson Bros. Corp., to lay 75 miles of 26-inch line from Blissfield, Mich., to Detroit, and 10 miles of 20-inch near Maumee, Ohio, to be started about the first of June.

Pennsylvania Gas Company had Harford Bros., Emporium, Pa., start in May 52 miles of 12-inch line from its mixing plant in Warren, Pa., to a mixing plant in Erie.

Springfield Massachusetts Gas Company awarded 25 miles of 6 through 18-inch pipe line and 4 miles of 8-inch line to be laid in Connecticut and Massachusetts to Hallen Company, Inc., Long Island City, who in turn began work in May.

Tennessee Gas Transmission Company started in May 156 miles of 24-inch from Hamburg to Syracuse, N. Y. H. C. Price Company, Bartlesville, is doing the job.

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Projects Completed

Crude Oil Lines

The Bay Petroleum Corporation completed 17 miles of 2, 3, 4 and 6-inch gathering lines connecting the recently discovered Olsson and Smolan fields of Saline County, Kansas, to its Lindsborg-McPherson pipe line.

Products Lines

Texas Pipe Line Company completed in May 56 miles of 10-inch line from Lawrenceville, Ill., to Mount Vernon, Ind. O. R. Burden Construction Corporation, Tulsa, laid the pipe and is now constructing a Wabash River crossing.

Natural Gas Lines

Dow Chemical Company completed 12½ miles of 12-inch line from the Bay City, Texas, vicinity to the Sweeny meter station. Houston Contracting Company, Houston, did the work.

Humble Oil & Refining Company completed in May 42 miles of 10-inch from its Anahuac gasoline plant to Gulf States Utilities plant near Beaumont, Texas. Houston Contracting Company was the builder.

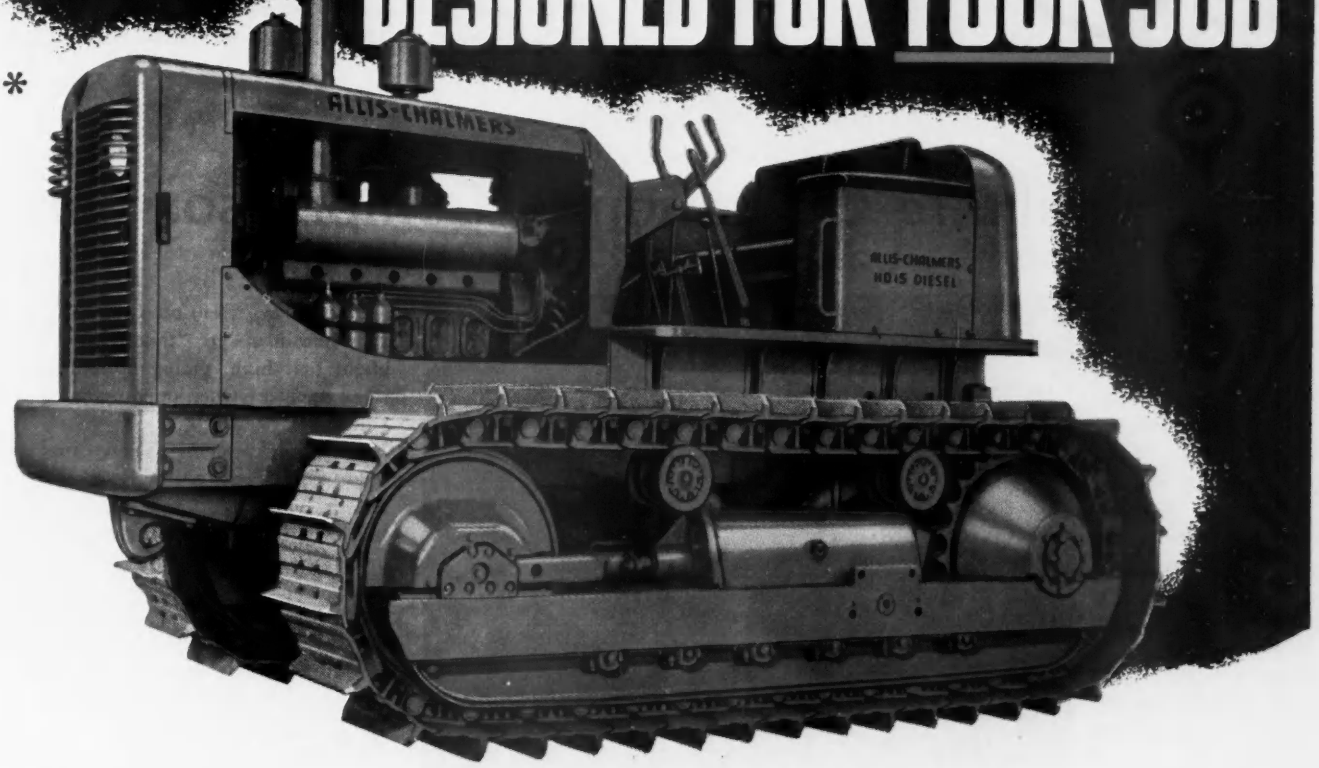
Phillips Petroleum Company had Trojan Construction Company lay 12½ miles of 24, 26, 30-inch in the Burbank field, Osage County, Okla., and the job was completed in May.

Southeastern Michigan Gas Company built 55 miles of 12-inch line connecting with Panhandle Eastern's line near Clawson, Mich. and running to Marysville, Mich. H. L. Gentry Construction Company, Jackson, Mich., was the contractor, and completed it in May.

United Gas Pipe Line Company completed 50 miles of 30-inch loop between Magnet-Withers field, Wharton County, to Missouri City, Texas Gulf Coast.

United Gas Pipe Line Company completed in May 48½ miles of 20-inch and 2-2/5 miles of 16-inch between Needville and Dow Chemical Co. plant, Freeport, Texas. Texas-Louisiana Contractors, Fort Worth, laid the pipe.

Here's what WE mean by DESIGNED FOR YOUR JOB



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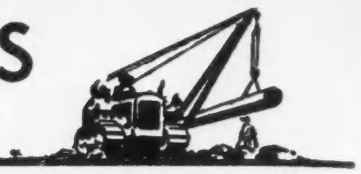
How to do it!

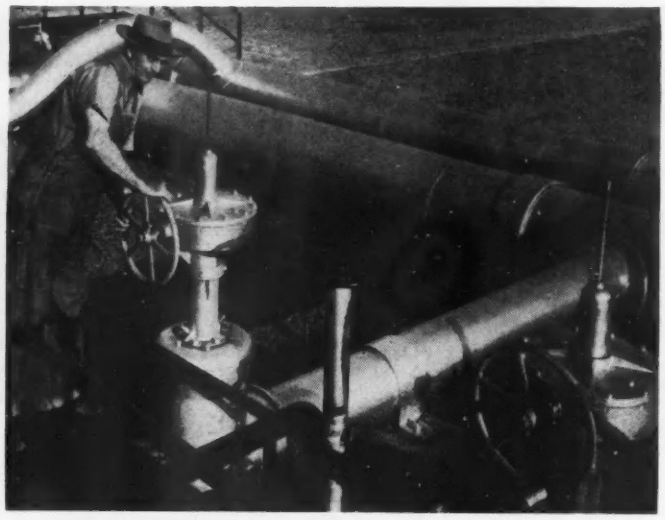
PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

HOW TO—Facilitate Operation of Compressor Valves

It is essential to good compressor station operating practice that bypass, suction and discharge valves be readily accessible, easily operated and easy to identify. One company evolved an almost ideal installation by locating all three of these valves for each compressor adjacent to the elevated walkway that runs parallel to the main compressor building, and having the valve wheels flush with the edge of the walkway. Of course, it was necessary to omit the top rail on the side next to the walkway.



The valve extension stem and elevated gear housings were "tailor-made" to reach about belt high, giving optimum leverage to an operator when opening or closing the valves.

For quick identification, the suction valve wheel was painted yellow, the discharge valve red, and the bypass valve black. This minimizes the chances that an operator will open or close the wrong valve.

When it is necessary for a compressor building to go off the line for any reason, it is often important to start a compressor engine hurriedly. At the installation pictured, the operator can open the bypass valve between suction and discharge lines, then open the suction valve, start the engine, open the discharge valve and close the bypass valve, without delay.

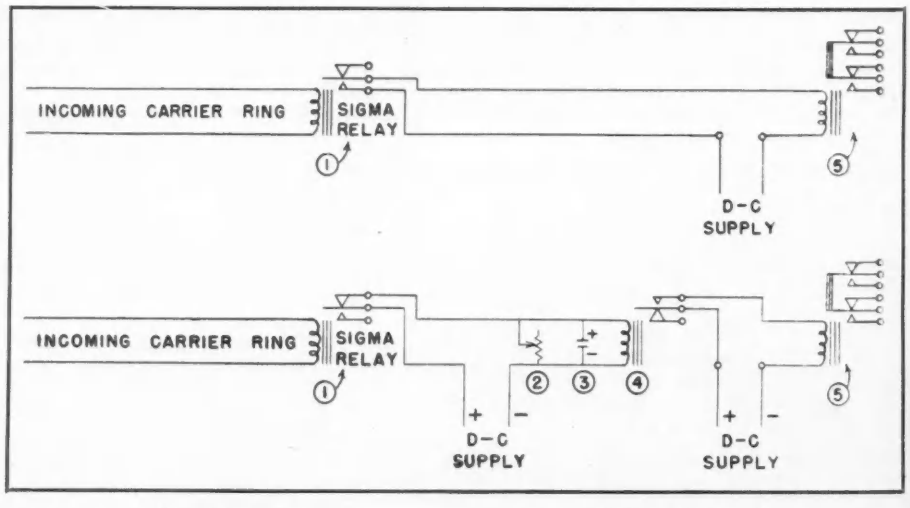
HOW TO—Improve Ringer Circuit for Carrier 'Phone

A ringing margin broad enough to cover the variations in telephone line attenuation can be provided in most cases by making three additions to the usual carrier telephone equipment. With some of the equipment used in pipe line communications, the ringing margin is so narrow that a small change in the telephone line attenuation makes it necessary to readjust the ringer circuit at each terminal. Changes in weather conditions and minor cases of line trouble are largely responsible for changes in attenuation.

The usual carrier equipment has a ringer circuit in the receiver side of the terminal, as shown in Figure 1. It can be greatly improved by adding a third relay, an electrolytic capacitor, and a potentiometer, as in Figure 2, parts 2, 3 and 4.

Part 2 is an 0-1000-ohm potentiometer; part 3 is a 500-microfarad- 150-volt electrolytic capacitor; and part 4 is a 1000-ohm plug-in type direct current relay.

The additional parts may be mounted on the carrier terminal panel, or on a separate chassis and set inside the terminal cabinet.



Top—Figure 1. Bottom—Figure 2.

The period of delay of the delayed action circuit shown in Figure 2 is controlled by the setting of the potentiometer. The improved circuit makes it possible to operate the ringing voltage level at a much higher level than in Figure 1. The ringing voltage level may be raised to the extent that relay 1 will chatter during conversation; however, the slow action of relay 2 will prevent any false rings from going through.

Invariably GO TO CLARK!

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So, as one would expect, a complex problem was faced in meeting the three-compression-stage requirements. But the fact that Gulf is experiencing highly satisfactory performance from Clark Compressors in other installations . . . the fact that Clark "Big Angles" are widely known for their great flexibility of compressor cylinder staging — their smooth, flexible operation under varying pressure conditions — their super power and compactness that effect savings in building, foundation and maintenance — *all played a part in Gulf's decision to go to Clark!* Nine Clark 2-cycle, BA-6, gas-engine-driven compressors, 1200 bhp each, are doing the job with eminent success.

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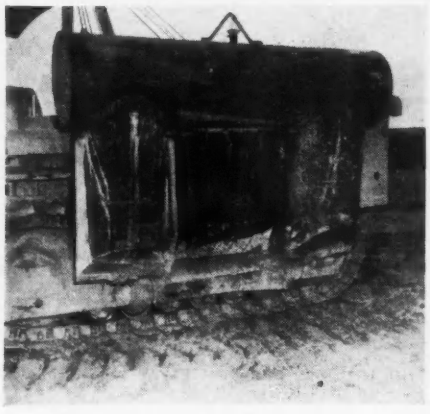
PIPE LINE HINTS

the set of weights already on the tractor.

In the case illustrated, the counterweight is filled with scrap iron and neat cement so that the entire weight has a density greater than reinforced concrete. When short spreads which require frequent transportation of equipment are contemplated, the counterbalance can be filled with water which may be drained to lighten the weights, thus reducing freight charges. Experiments have also been made using barytes, which gives a weight slightly heavier than reinforced concrete and can be removed through manholes in the pipe.

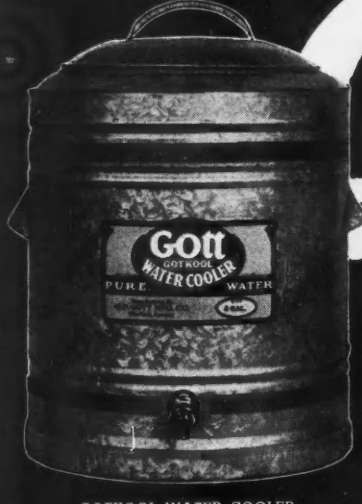
The weights are hung on a section of angle iron welded to the frame of the tractor, and they do not interfere with normal tractor operation. A bale welded to the top of each of the weights facilitates handling with a winch truck.



HOW TO—Protect Pipe During Haul

Coated and wrapped pipe being hauled to the job can be protected by pads fastened as shown to the bolsters of the truck.

The pads are made by filling long sacks of army ducking with excelsior. They are then tied to the bolsters. The two bolsters which carry most of the pipe weight are



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equipped with cradles to fit the size pipe being hauled. The cradles are made by tack-welding short lengths of four-inch pipe to the top of the bolsters on spacing equal to the diameter of the pipe being hauled. A section of belting laid over the four-inch nipples is fastened down with the excelsior sack on top.

By taking extra precautions to prevent damage to pipe coating, the trouble and expense of patching many holidays in the coating can be saved.

HOW TO—

Build Pipe Supports For Gathering Lines

Simple pipe supports that hold gathering lines above a salt water beach also anchor the lines in place during floods caused by high tides driven by off-shore winds.

Originally these lines were buried in the sandy beach of an island terminal which was subject to frequent flooding. Inasmuch as the sand was constantly saturated with salt water, corrosion forced an early replacement of the lines. The simple pipe supports shown were designed to hold the lines above the sand and at the same time anchor them in time of flooding.

The supports were constructed by driving two pieces of extra-heavy four-inch pipe as far as possible into the ground on opposite sides of the gathering lines. About two feet of pipe were left standing above the surface and bull-plugged. Between the two driven pieces of pipe, about six inches above the sand, a length of four-inch pipe was saddled across to complete the pipe support. Wire rope was used to lash the gathering lines to these supports to prevent flooding water from damaging them.

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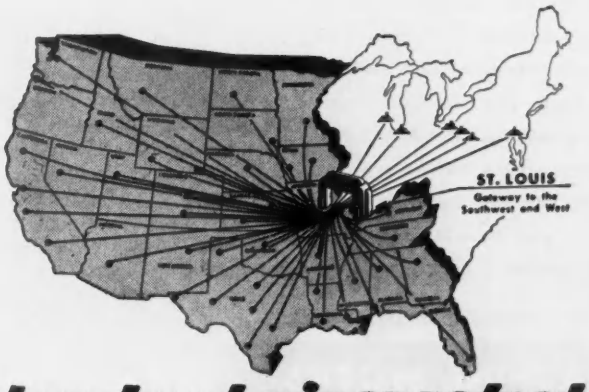

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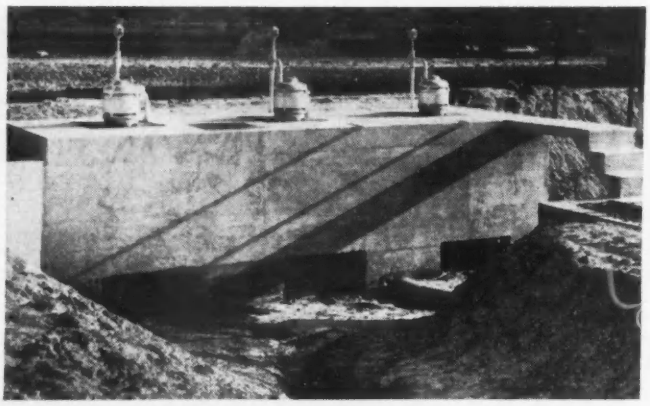
HOW TO—Drain Swampy Site for Compressor Station

An economical solution was devised by a company faced with the problem of draining a compressor station located in a swampy area.



Instead of obtaining additional dirt from outside the plant site to fill in the area, the company graded the plant yard in such a way that all surface water runs to ditches that partially surround the site.

The ditches are sloped to sump pits, one of which is illustrated. In each of the two sump pits are three trash pumps capable of handling all the run-off water that comes from the plant grounds during and following even the heaviest of rains. Each of the pumps has an individual float switch set at an elevation different from the others, so that the pumps go into operation one at a time, as the water comes progressively higher. Only in flood stage will all three be running simultaneously.

The water lifted from the sump is spilled into a nearby lowland.

This installation has more than paid for itself, for the cost of hauling in enough dirt to raise the elevation of the plant site above that of the surrounding countryside—the usual solution to the problem—would have been many times more expensive.

HOW TO—Make Ground Wire Clamp for Welding

A simple ground wire clamp may be made using a wire line clamp and a section of pipe the same size as the pipe that is being welded. A coupon approximately two inches wide is cut off the end of a joint approximately half the circumference of the pipe. A handle is then welded to this as shown.

A wire line clamp which fits the ground cable is then turned up on the coupon, and the U-bolt of the clamp is welded to the coupon. This allows the roddle of the clamp to be removed and the ground cable inserted and fastened down by tightening the nuts on the clamp. The cable can be easily removed by loosening the nuts.

In operation, the cable is fastened to the clamp, which is on the proper ground connection, and the entire assembly is moved down the pipe as the welder completes each joint. When it is necessary to move the welding unit to another job, the nuts are loosened and the ground cable removed and inserted into the proper clamp for the job at hand.

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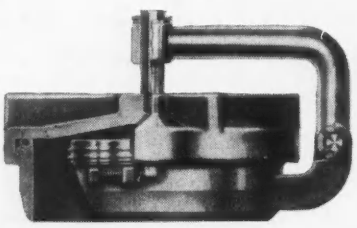

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Oil Strengthens Prairie Economy

By BRUCE MacKINNON

Imperial Oil, Ltd., Toronto

OIL HAS contributed substantially to Canada's economy —especially in the western provinces—and the impact of this vital resource will be felt more and more as new reserves are discovered and developed. With all the benefits derived from petroleum, however, the price of the refined product delivered to the public has not risen in proportion to other vital commodities and labor costs. As in the U. S., the Canadian oil industry can cite this example of free enterprise at its best.

IN LESS than four years the new oil activities in Alberta have brought many benefits which have resulted in strengthening the economy of Canada in general and Alberta and the prairies in particular.

Canada's prairie provinces are benefiting from lower prices for oil products. This has come about as a progressive development accompanying the transformation of the Canadian oil industry.

The prairie price benefit is only one of the many changes in Canada brought about by the new discoveries of oil. Because of geography, Alberta and the prairies have benefited first and most directly. To Alberta the new oil has meant the development of a great new industry second only to the province's agriculture; the establishment of new businesses; wider employment; higher living standards; and enlarged and improved government services and facilities provided by provincial revenues from oil.

The extent of the transformation of Alberta's oil industry was defined by G. L. Stewart, president of Imperial Oil, Ltd., when he pointed out that:

"Before Leduc was discovered in 1947 the estimated proven oil reserves in Alberta were 45 million barrels; today they are well above the billion barrel mark.

"Before Leduc, oil exploration and development expenditures on the prairies were about $12 million per year; this year they are estimated at more than $12 million a month.

"Before Leduc, Alberta had 525 producing wells with only one important oil field—Turner Valley, where production was declining; today the province has approximately 1800 producing wells, a substantial list of proven fields of which Leduc-Woodbend and Redwater at least rank as major oil fields in any oil man's eyes. Added to the list are last year's finds which remain to be evaluated.

"Before Leduc, prairie refining capacity was 40,000 barrels daily, of which less than half was from prairie crude; today, light crude operating capacity is 70,000 barrels daily which can be completely supplied by prairie crude."

Completion of the Interprovincial Pipe Line has enlarged the outlet for Alberta oil by opening a quick route, partly by sea, to the Ontario refineries.

When crude began to move October 4 through Interprovincial Pipe Lines from Edmonton to Regina, the following general forecast of petroleum prices in the prairies could have been made. Some of these changes have, of course, already taken place:

- Winnipeg and most of Manitoba: Lower prices for gasoline and other oil products in October, followed by substantial reductions in the spring and summer.
- Regina and most of south Saskatchewan: Sharply lower gasoline prices in October, followed by further moderate reductions in the spring.
- Alberta and northern Saskatchewan: No price changes looked for until spring, when a moderate reduction is expected.

Long-term predictions are not always accurate, whether about prices or the weather. Yet the beginning of the eastward movement of Alberta crude by way of the

pipe line was so definite and calculable a matter that fairly precise forecasts could be made.

Such a forecast was made September 20 by Imperial's executive vice president, John R. White. Speaking at Winnipeg, he said: "No matter what happens to world prices, Winnipeg prices will still be between 4 and 5 cents lower than they would have been if this crude oil movement to Sarnia had not taken place." Prices in the prairies would, in short, continue to feel the effect of worldwide price movements, but by next spring they would ride up or down at a comparatively lower figure.

Reasons for Price Cuts

There are two main reasons for these price cuts, both tied up with the pipe line. Last fall, the pipe line reduced the cost of moving oil to Saskatchewan and Manitoba refineries, bringing a saving that was passed along to the consumer. This spring, the pipe line (plus new tankers, docks and storage) made it possible to send Alberta oil to the lower Great Lakes. To get this larger volume of business, the producer will reduce his prices and so provide another saving for the prairie consumer.

Like most of the recent oil development in Western Canada, the price reductions stemmed from the discovery of crude at Leduc in February, 1947.

At that time, the first crude from the new reservoir found its market in refineries at Moose Jaw and Regina. To do so, it had to sell at a price that would compete with oil from the fields—Turner Valley in Alberta and Cutbank in Montana—which would otherwise have supplied those refinery centers.

It was about 1½ years later before the supply of Alberta crude had grown enough to require a substantially larger market. Edmonton had become a market for crude with the completion of Imperial's refinery, and reserves had grown to the point where Alberta could look to supplying the entire prairies. That meant that the Alberta crude producer had to offer his crude cheaply enough to compete at Winnipeg. Alberta crude, delivered at Winnipeg, had to sell for the same price as Illinois crude at Winnipeg and so the crude producer near Edmonton had to key his offering price to the Winnipeg crude price, less, of course, the rail freight needed to move the oil 800 miles eastward.

Obviously, this new jump to the east meant a sizable hike in freight costs for the producer to absorb, and in order to meet competition at Winnipeg, Alberta crude had to come down in price. It did, from $3.45 a barrel at Leduc to $2.95, a cut of 50 cents a barrel. Of course, it also meant larger markets for the growing fields, and where production at the time of the price cut (December 1, 1948) was 38,000 barrels daily, output had moved up to around 55,000 barrels daily by the middle of 1949.

The 1948 drop in crude prices brought down Edmonton gasoline prices from 23.1 cents a gallon to 20.7 cents at wholesale. For the first time, Edmonton tankwagon prices for gasoline were as low as those at Calgary which had formerly been Alberta's lowest price center because of nearby Turner Valley.

That 1948 price pattern, with crude keyed to meet competition at Winnipeg, has prevailed to the present, and will likely continue to be the basis of prices until next spring when the oil begins to move to Sarnia. At that time, Sarnia will replace Winnipeg as the key, or fringe market, and competitive conditions at Sarnia will govern the price of crude at the fields.

Until the pipe line opening, there had only been two major influences to change gasoline prices since the end of 1948. One of these was the devaluation of the Canadian dollar in September, 1949. Devaluation meant a rise in the Canadian dollar price of competitive, imported crudes at Winnipeg, and a consequent rise in wellhead prices for the producer in Alberta. In Canadian dollars, Leduc crude moved up from $2.95 to $3.20. This price prevailed until the Canadian dollar was freed from controls permitting a downward readjustment.

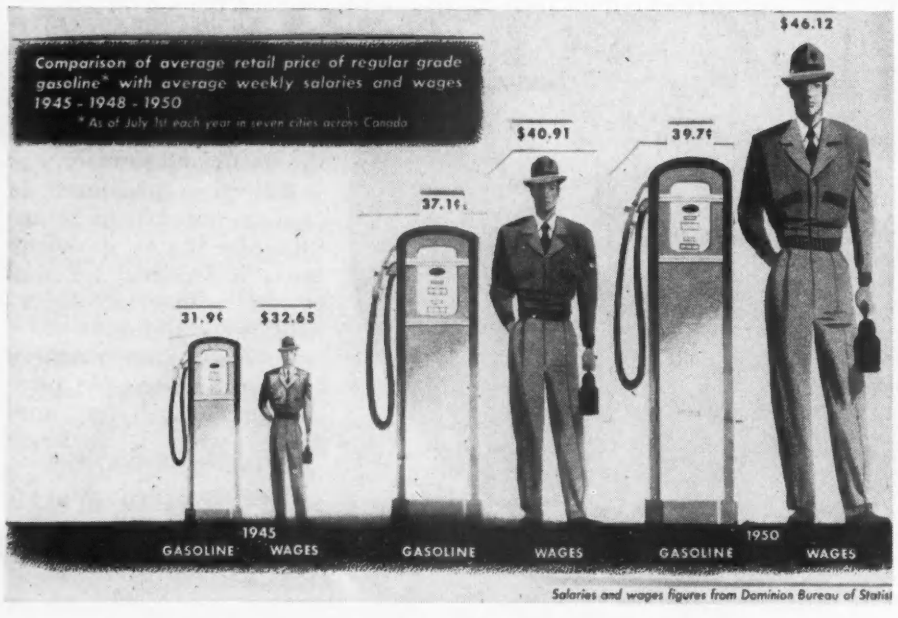
Other changes in prairie wholesale prices have followed the upward movement of transport costs, brought about by a series of freight rate increases totaling approximately 45 percent in most of the prairies.

Refining at Edmonton

Partially offsetting the rise in freight costs in central Alberta and northern Saskatchewan has been the growing stature of Edmonton as a refining center. From an initial capacity of 6000 barrels daily, Imperial's Edmonton refinery has grown to 20,700 barrels daily. With its expansion has come a widening of the area it can supply and now Edmonton serves a wide area in north and central Alberta together with northern parts of Saskatchewan. This region, of which Edmonton is the core, has been better insulated than any other part of the prairies against the rising trend of transport costs. Wholesale gasoline prices at Edmonton in the past summer were actually 7 to 9 cents a gallon lower than they would have been if the city had still been supplied with crude or oil products brought in from the outside.

That was the situation in September. It could be summed up by quoting the existing wholesale tankwagon prices for Esso gasoline at the key prairie points: Edmonton, 21.4 cents; Calgary, 22.0; Regina, 26.9; and Winnipeg, 28.2. Those prices reflected the way in which rail transport costs boosted prices as distances from Edmonton increased.

The reductions which took place last fall were made possible by the saving in transport costs for crude out



Wages in Canada have risen much faster than gasoline prices.

of Edmonton. Because there has been no reduction in transport right at Edmonton, the base price reflected only the change caused by the rise in foreign exchange value of the Canadian dollar. Nor was there any transport saving at Calgary, which is off the route of the new pipe line. But at Regina, whose refineries formerly had to work with crude railed in from Edmonton, the saving was substantial. And at Winnipeg, there was also an important cut, though the autumn reduction was not as great as for Regina. By the end of last October, prairie prices for regular gasoline were as follows: Edmonton, 20.7 cents; Calgary, 21.3; Regina, 22.2; Winnipeg, 25.7.

The reason for the smaller Winnipeg reduction last fall was that Winnipeg as yet does not have sufficient refining capacity to meet the needs of the Winnipeg area. Until the 10,800-barrel Imperial refinery is completed early this summer, Winnipeggers will be supplied mainly with imported products refined at Regina or in Eastern Canada. Ultimately, the saving in transport costs and product prices will be greater at Winnipeg than any other prairie point.

1951 Price Cuts

Cuts in 1951 will be based on the anticipated reduction in crude prices at the wells, a reduction made necessary because the Western crude producer will then be shipping to the lower lakes. To reach that point, his oil will have to pay high freight costs despite the benefit of pipe lines and large tankers. On arrival, Western crude will have to be priced low enough to compete with crude from the Mid-Continent fields of the U. S. It all adds up to a reduction in price back at the wells. This reduction will lower the cost of crude at all the prairie refining centers, a saving which will be the basis for the 1951 price cuts to the consumer. On his side of the picture, the producer will have bigger sales to make up for the lower price at which he sells.

The 1951 cut in wellhead prices will not change the price to Ontario consumers supplied out of Sarnia refinery. The December, 1948, reduction in crude at the wells did not bring a reduction in wholesale gasoline at Winnipeg, since Winnipeg was the key market which governed the price at that time. In 1951, Sarnia assumes that role.

Actually, in order to reach the lower lakes, the Western producer will have to establish a lower wellhead price than prevails in the Mid-Continent fields which supply the area. He will get no more for his oil at Sarnia than the Mid-Continent producer, but, being farther away from Sarnia, will have to pay more to move his oil there.

After the 1951 reductions, what? Will there be still further cuts in prairie prices? Will the low prices in the prairies extend farther east or farther west?

The answer hinges on three things, none of which can be predicted at the present time: The future value of the Canadian dollar; the future course of world oil prices; and the future markets found for the growing output of western oil.

About the Author

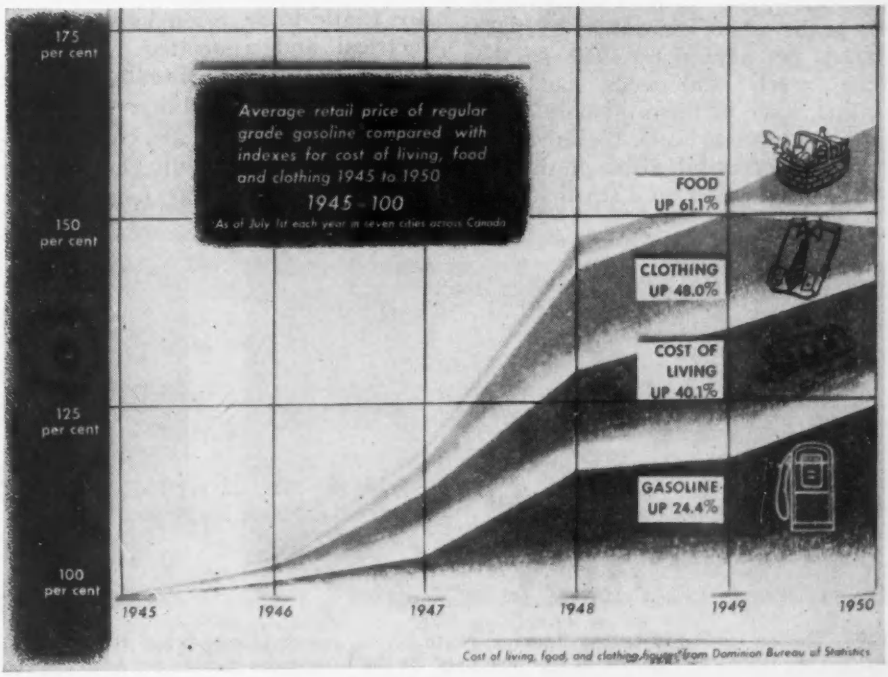
BRUCE MACKINNON, management assistant, Public Relations department, Imperial Oil, Ltd., was born in Birmingham, England, spent his early years in Buffalo, St. Catharines and Toronto, and graduated from the University of Toronto in commerce and finance. After two years in the investment business he joined Maclean-Hunter Publishing Company with the *Financial Post*, of which he became managing editor. During his last two years with Maclean-Hunter he was director of editorial research for that company. He joined Imperial Oil on November 1, 1948.

In Summary

- In 1949 prairie consumers would have spent an estimated $30 millions more for petroleum products if crude from the new Alberta fields had not been available. This saving was almost entirely in Alberta and Saskatchewan, but it would have worked out to an average of $11.95 for every man, woman and child in the three prairie provinces.
- In 1950, lower cost pipe line transportation extended the savings in Saskatchewan and Manitoba with an estimated total of $35 millions for the three provinces of $13.94 per capita.
- Delivery of Alberta crude to Ontario refineries in 1951 is expected to result in lower crude prices at the well which would permit further product price savings on the prairies. It is estimated the total will reach $55 millions or an average of $21.91 per capita.

ACKNOWLEDGMENT

Information for this article was furnished by *Imperial Oil Review*.


175 per cent
150 per cent
125 per cent
100 per cent
Average retail price of regular grade gasoline compared with indexes for cost of living, food and clothing 1945 to 1950
1945 - 100
As of July 1st each year in seven cities across Canada
FOOD UP 61.1%
CLOTHING UP 48.0%
COST OF LIVING UP 40.1%
GASOLINE UP 24.4%
1945
1946
1947
1948
1949
1950
Cost of living, food, and clothing figures from Dominion Bureau of Statistics

Since 1945 the price of gasoline in Canada, compared with other commodities, has risen least.

Far East Gets Emphasis

Borneo Production Mounts

THE increasingly tense international situation, coupled with difficulties in the Middle East, renders especially significant the mounting oil production of British Borneo.

Crude in varying quantities has been obtained from Miri in northern Sarawak since 1910, but this field declined rapidly after its peak production of 5,494,000 barrels in 1929. Today it is the Seria Anticline on the coast of the adjoining state of Brunei which is the principal source of Borneo crude.

Oil production from Seria has now reached a record rate of 100,000 barrels per day, that is, about 36,145,000 barrels annually, or five times that of the best prewar days.

Seria reached this peak despite the havoc of war damage. It was twice demolished—first in 1941, immediately before the Japanese invaders arrived, and then in 1945, when Australian reoccupation forces were approaching.

Discovered by Shell in 1929 after years of painstaking exploration in the region, this oil field was producing at the rate of more than 7,229,000 barrels per annum by 1940. At that time nearly 150 wells had been drilled, some of them offshore. Japanese attempts to work the area were none too successful, although they did renew production on a small scale.

By the end of 1945 Shell technicians had started re-drilling, and in March, 1946, the first postwar cargo of crude was shipped for refining in Australia. On Christmas Day, 1946, Lutong Refinery in Borneo itself, and only about 30 miles by pipe line from Seria, came back into operation, and since that date progress has been rapid. The greater part of the new equipment on the oil field has been obtained from sterling sources.

The geological picture of this area comprises a very great thickness, probably more than 30,000 feet of Tertiary rocks which were deposited in the subsiding East Indian geosyncline and were later affected by Alpine folding movements. In Java, Sumatra and Southern Borneo the folding was PlioPleistocene, and in Northern Borneo it was PlioMiocene.

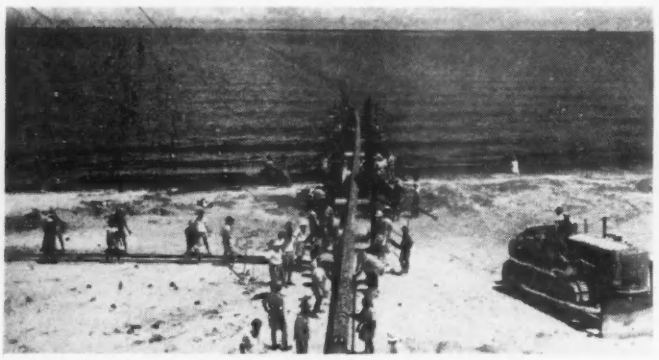
The islands along this arc are mainly geoanticlines with exposed cores of preTertiary rocks, on either flank of which are Tertiary geosynclines. The Tertiary strata lie unconformably on older rocks.

The best petroliferous structures are gentle folds, often locally asymmetrical and associated with some degree of thrusting. Productive horizons are mainly Miocene, but in Ceram and Tarakan are chiefly Pliocene. They are generally clayey sands between 1500 and 4000 feet deep.

The age of this oil is almost certainly Miocene, having been formed in the great thickness of relatively deep-water marine Miocene sediments which underlie the continental Pliocene rocks. In Borneo, the Eocene yielded 30,000 barrels in 1939, so it is possible that this system will yield further oil pools when exploited. There is also some Triassic oil in Timor.

About 270 wells have been drilled in the Seria field. Its limits have yet to be established and active offset drilling is in progress. Geological and geophysical (gravity and seismic) surveys are being conducted in the colonies of Sarawak and North Borneo and in the state of Brunei.

The only refinery in British Borneo is at Lutong in Sarawak. It had to be completely rebuilt after the end of the war, and was enlarged to include both old and new distillation units. It receives part of the crude output of Seria as well as treating the modest quantities produced at Miri and has a daily throughput capacity of 38,000 barrels. Direct exports of refined products go to neighboring Far Eastern countries, while crude is sent for refining to Pladjoe and Balik Papan in Indonesia, as well as to Argentina, Japan and countries in Europe. California has recently been added to the widespread markets already served.



LEFT: Tankers loading at Lutong, Sarawak, North Borneo, cannot venture nearer than 2½ miles to the shore because of shallow water. Instead, cargoes are loaded at terminals of four pipe lines. On the horizon can be seen the Admiralty tug "Enigma," towing an LCT to which the sea end of the pipe has been attached. In the foreground the figure 11 painted in white on the pipe indicates that 11,000 feet has been paid out. RIGHT: War-damaged and new tanks in old tank farm.

A Long Haul to Russia

Iran's Best Bet: Britain

WITH more than 240 million barrels of crude production a year at stake, the settlement of the boiling Iran controversy may take one of three possible directions, two of which could cripple the Western Powers' rearmament program and affect adversely the economics of several European countries.

- The physical control of the Anglo-Iranian Oil Company properties may pass into Iranian hands under a negotiated arrangement with Britain following the passage of the nationalization statute, and the Iranians may continue to meet the company's contractual obligations to its present market with the technical assistance supplied by the currently-employed 2700 skilled Europeans.
- Iran, at the behest of political extremists, may offer its oil production to Russia.
- The Moslems may seek other oil outlets should a complete break with Britain develop.

If Iran pauses to consider seriously Britain's insistence on negotiation or arbitration and the U. S. State Department warning that it cannot expect American technical assistance if it assumes complete control of the oil company, the Moslems probably will continue to supply the present market under a semi-autonomous arrangement.

An arbitrated agreement on the operation of Anglo-Iranian might be acceptable to Britain, which fears its supply of crude would be drastically cut if Iran attempts to operate the oil fields and the refinery at Abadan without foreign assistance. Any reduction in its crude supply might force Britain into a drastic gasoline rationing program and slow its rearmament program.

Russia long has wanted Iranian oil, and Iran, if it fosters an outright break with Britain, might consider diverting its crude production to its big Communist neighbor. But if it were possible to do so, the military advantages to Russia must be minimized.

Russian control of the Middle East would result in loss of the oil to the Western Powers, but Ralph G. Follis, chairman of the board for Standard Oil Company of California and director of the Arabian-American Oil Company, says "the danger of their availing themselves of the oil is almost nil."

Follis returned from an inspection of oil installations in the Middle East and Southeast Asia and expressed optimism about the prospects of a British-Iran settlement.

"I can't see how Iran can afford not to work this out with the Anglo-Iranian," he said in a copyrighted interview in the *U. S. News and World Report*, an independent weekly magazine published at Washington.

"The only people who have a market to absorb this tremendous amount of oil is Anglo-Iranian. They are the only people who have the ships to move that oil—it takes a tremendous amount of ships to move 500,000 barrels a day of refined products they make at Abadan to the markets that can absorb it. And the Anglo-Iranian has the markets, and if they got their oil somewhere else and closed that gap, I can't see what Iran would do," Follis said.

Tremendous Task

Moving Anglo-Iranian's crude and refined production to Russia overland would be next to impossible because of the tremendous difficulties awaiting any attempt to build pipe lines across Northern Iran's mountain ranges. The oil would then have to be moved to consuming centers. To move such tremendous amounts of petroleum and refined products hundreds of miles across the Caspian Sea would be a monumental task, if not an impossible one.

Follis said, "It is hard for me to see, unless the Russians had complete control of the air and sea in that whole part of the world, how they could ever get the oil out."

The chances of Iran obtaining adequate markets elsewhere in the world are remote. There are other countries eager for oil supplies but none which could fashion a tanker fleet necessary to transport the immense Anglo-Iranian output.

It was believed settlements of demands for higher royalties in Iraq and Kuwait could be reached through negotiations. The Iraqi government earlier indicated it would be willing to reach an agreement with Iraq Petroleum Company for continued operations of its concession in the country on the basis of a profit sharing arrangement similar to the Saudi Arabian-Aramco plan. The Sheik of Kuwait has made a request to Kuwait Oil Company, Ltd., to discuss a similar royalty arrangement. A defeat of the Western position in Iran, however, possibly could have some bearing on final settlement in either of these nations.

Despite the uncertainties of crude production, the Middle East concessions continued to rise in the first part of 1951. Production in Iraq, averaging about 170,000 barrels daily in the first quarter, is running nearly 50 percent over the like three months of 1950 and has registered the sharpest increase in the Middle East. Arabian American's production in Saudi Arabia is rapidly increasing and nearing the level of leading producer Iran. Aramco's output in the first three months of the year averaged 611,286 barrels a day, up from a daily average of 452,635 in the like 1950 period.

Kuwait Oil Company's production is showing sharp gains over 1950, with an average of 389,962 barrels a day in the first quarter of this year, compared to 283,694 barrels per day in the January-March period of 1950. Despite crippling strikes and its uncertain future, production from Iran by Anglo-Iranian in the first quarter was ahead of a year earlier at a daily average of 679,785 barrels. Production of Bahrein Petroleum Company from Bahrein Island, where the Iranian Communist Party recently demanded nationalization action, averaged about 30,000 barrels daily in the first three months of the year, approximately the same as in the like quarter of 1950.

Iranian Controversy Has Widening Repercussions

Repercussions of the Iranian controversy echoed through Southern and Eastern Europe last month.

Word from Budapest was that the various oil organizations created by the Russians in their Balkan satellites have been told to follow closely the oil situation in the Arab countries. Furthering this policy, a group of "Hungarian mechanical engineers" planned a trip through Iran, Iraq, Egypt, Saudi Arabia and Israel to study the market. Significantly, the group included two members of the Hungarian-Russian Oil Company, described as experts in oil and petroleum products equipment.

In Italy, the Azienda Generale Italian Petroli (AGIP), government monopoly, was saying that developments in Iran confirm action taken against private enterprises in the Po Valley since "only a state monopoly can guarantee the independent supply of oil and gas during an emergency period, and prevent the country from remaining without imported oil and petroleum products." Using this as the theme of its demands, AGIP has obtained from the Italian treasury an allocation to complete projected gas lines within 1953 "so that in case of emergency Italian industry and transports might figure on supplies of methane gas from the Po Valley."

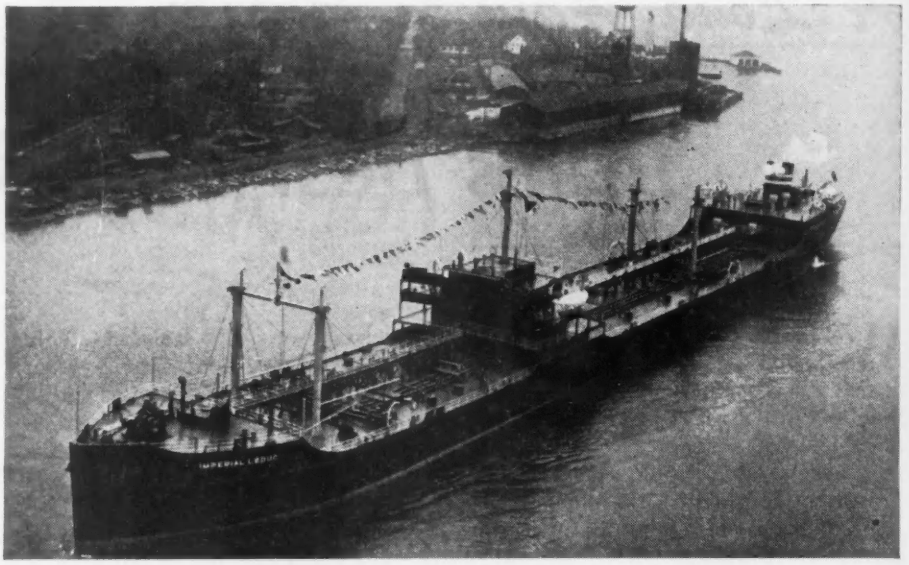
Venezuelan Output Nearly 1,700,000 Barrels Daily

Venezuela's rising production is now nearly 1,700,000-barrels daily. For the week ending April 16, daily average production by operators was as follows:

COMPANY	Western Venezuela	Eastern Venezuela	Total
Creole	579,721	141,272	720,993*
Shell Co's	516,946	.....	516,946*
Mene Grande	62,108	230,487	292,595
Texas-Mercedes	16,371	32,243	48,614*
Socony	.....	47,605	47,605
Atlantic	.....	20,333	20,333
Richmond	14,214	.....	14,214
Sinclair	.....	12,695	12,695
Pantepec	.....	10,217	10,217
Phillips	.....	6,182	6,182
BCO, Ltd.	967	.....	967
Total	1,190,327	501,034	1,691,361

The figures marked with an asterisk (*) are all-time production highs for the companies concerned.

Crude From Alberta Fields Completes 1800-Mile Trip



Ending a historic journey and her maiden voyage, the 620-foot "Imperial Leduc," largest lake tanker in the world, is shown in the St. Clair River just before docking at Sarnia with the first cargo of Alberta crude to reach Ontario. This is how she looked from the Blue Water International Bridge as she passed underneath on her way to the dock.

A LITTLE more than four years after the first discovery of prolific oil deposits in Western Canada, crude from Alberta reached the large consuming area of Ontario. The oil had traveled 1100 miles by the new Interprovincial Pipe Line from Redwater field, near Edmonton, to the eastern terminal at Superior, Wis., and from there another 700 miles by tanker across the Great Lakes to Imperial Oil, Ltd.'s, Sarnia refinery.

The S.S. Imperial Leduc, named for the first major postwar discovery in Alberta, hauled the first crude into Sarnia. Joined by other Imperial tankers, the fleet is expected to move a total of 10,700,000 barrels of Alberta crude to the Ontario refinery during the 1951 navigation season on the Great Lakes. This is approximately the equivalent of 50 percent of the Sarnia refinery's requirements for the full year. With the completion of planned capacity expansion of the Interprovincial line, Imperial officials forecast 1952 deliveries of Alberta crude to Eastern Canada will increase to about 17 million barrels annually.

Shipments of Alberta crude via pipe line and tanker eastward marks the start of the Canadian desire to become less dependent upon imports for filling its petroleum demands. Production in the Prairie Provinces heretofore has been limited largely to what could be consumed in the immediate area. Following the initial spring shipments of crude to Ontario, the Alberta production allowable was boosted by 22,570 barrels a day to a new high of 98,046 barrels daily. With the increased shipments, Imperial in late April reduced its posted prices for Redwater crude 29 cents to $2.44 a barrel, making it competitive with Illinois crude at Sarnia. Other downward adjustments in postings by Imperial were Luduc, $2.61 a barrel, down 44 cents, and Turner Valley (41 gravity), $3, down 35 cents.

Flying Magnetometer Survey Completed in Venezuela

Aerial magnetic studies of a 600-square-mile area near the southern part of the Gulf of Venezuela were completed recently for Venezuelan Atlantic Refining Company. The study is the first aeromagnetic survey of the area since 1948, and is part of Venezuelan Atlantic's broad exploration program.

The survey, with aerial reconnaissance performed by Aero Service Corporation, was flown at an altitude of just under 1000 feet over a rectangular grid pattern with flight lines spaced at intervals of from approximately 1000 to 2000 yards. Since much of the survey area is under water, the mapping plane towing a high sensitivity magnetometer was guided by Shoran, the electronic plane positioning device.

The survey was made under the direction of Richard C. Harris, recently appointed resident manager for Atlantic's operations in Venezuela.

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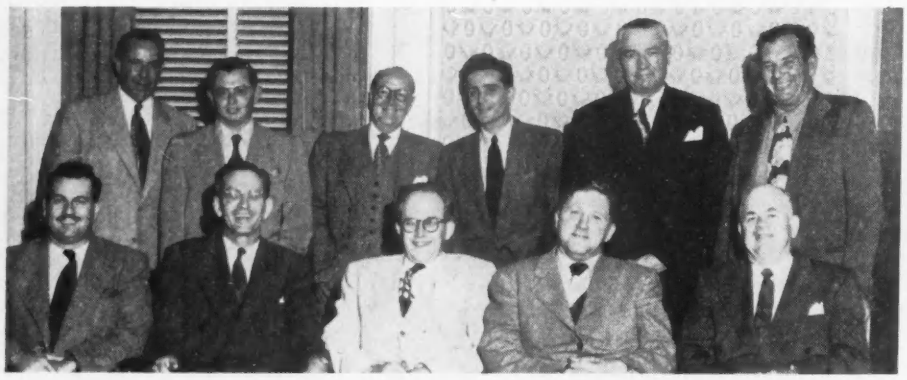
Of World Oil Men

AFTER 40 years' association with the international oil industry, Dr. H. M. E. Schurmann, chief geologist of the Royal Dutch-Shell Group, has retired. Dr. Schurmann's career with the Shell companies dates back to 1913. He was assigned first to Egypt, and later was transferred to Indonesia, where he worked until 1930. In that year he returned to the Netherlands and was placed in charge of the Geological department of Bataafsche Petroleum Maatschappij at The Hague. He held that post until his recent retirement.

INTERNATIONAL Petroleum Company, Ltd., is transferring its administrative offices from Canada to Florida. L. P. Maier, president, described the move as necessitated by the quickening pace of world affairs making it desirable for the executive officers to maintain a more direct and closer contact with the company's operations in Colombia, Peru and Venezuela. International will continue to maintain an office in Toronto for corporate matters.



Foreign Guests at a recent meeting of the Los Angeles Chapter of Nomads were, left to right, front row, Sam W. Landis, L. Saavedra e Hijos; Z. W. McCoy, California Texas Company; Charles Wilkinson, formerly Drilling and Exploration Company; C. M. White, Iraq Petroleum Company; and Ralph H. Connors, Iraq Petroleum. Back row, left to right, T. S. Foster, N. V. Standard Vacuum Petroleum Mij.; Manuel Carrera, Empresa Petrolera Fiscal, Peru; Hugh Thompson, Richmond Exploration Company; Norman M. Bain, Shell Oil Company (London); J. D. Bryan, Superior Pipe Service (Venezuela); and A. F. Michel, Phillips Oil Company (Venezuela).

Five Foreign Countries were represented at the 1951 Southwestern Gas Measurement Short Course held at the University of Oklahoma, Norman, Okla., and attended by nearly 1000 from the gas industry. Pictured, left to right, front row, are Homer N. Mead, Venezuela; L. A. Prudhomme and K. O. Rubie, Canada. Back row, C. La Verdure and H. W. Newby, Canada; and Jose G. Trevino, Mexico. Not shown are Jean Seguret, representing Tunisia; J. Puech, representing Algeria, and W. F. Byers, from Canada.

HARRY B. BRITTON has been elected a vice president of Trans-Arabian Pipe Line Company. A graduate of the University of Illinois in 1924, Britton has been associated with the oil industry for nearly a quarter of a century. Following four years of service in the U.S. Navy, he joined Shell Pipe Line Company in 1928 and in his 14 years with the organization served as master mechanic, engineer, field engineer and chief refinery engineer. Britton joined Plantation Pipe Line System in 1942 as chief engineer, and was later general superintendent. Following this he started his service as consultant on the construction of Tapline.

Harry B. Britton

EDWARD C. BORREGO, has been appointed general manager of Tropical Oil Company, International Petroleum Company's affiliate in Colombia. Borrego, formerly assistant general manager of International in Peru, began his South American oil career in 1935 in Venezuela as district superintendent of Creole Petroleum Corporation, which along with International is affiliated with Standard Oil Company (N.J.). During World War II he served in the U.S. armed forces and during 1945 and 1946 in the U.S. State Department. Prior to going to Peru in 1950 Borrego was with Jersey Standard in Europe.

History of Oil Achievement Shows There Is

No Substitute for Free Enterprise

By JOSEPH E. POGUE
Petroleum Consultant, The Chase National Bank, New York

THE INITIAL parallelism and subsequent divergence of the discovery and development of oil in the U. S. and Russia offer a brilliant example of the results of government monopoly vs. free enterprise. This article is from a talk given before the American Chamber of Commerce at Rio de Janeiro April 10.

THE STORY of oil goes back to remote antiquity. History makes repeated reference to the solid residues gathered from oil seeps; the "eternal fires" of ancient Persia became the basis for religious worship. Even Noah is reported to have waterproofed the Ark with a lining of pitch. Thus oil may be said to have started its useful career by furthering the escape of man from the elements and it is now opening the third dimension to his release from the limitations of time and space. On every side we see the "wings of petroleum," the symbol of a new age.

As an industry, oil is young. Its birthday was about 90 years ago. "Discovered" almost simultaneously in the U. S. and Russia, oil in the two countries followed at first parallel but eventually divergent courses. In each, exactly 30 years elapsed before production attained a level of 100,000 barrels daily. For three years, 1898-1901, Russia actually exceeded the U. S. in oil output. Then the two paths diverged. Russian production did not regain its 1901 peak until the lapse of nearly three decades, hampered as it was by strikes, riots, religious warfare, the imposition of prohibitive royalties by the government, and finally by nationalization. In the meantime, under the drive of a sustained incentive, the U. S. forged ahead in continuous expansion so that today the output of oil in the U. S. is about eight times that in Russia.

This initial parallelism and subsequent divergence emphasizes and contrasts two ways of action—the individualistic and the collectivist. For many decades the motivations surrounding oil were not too unlike in the two countries, but around the turn of the century conditions changed. In the U. S., individual enterprise continued to be encouraged: in Russia, there was progressive interference by the state and eventually this agency took over entirely.

Oil is important to Brazil in two related but entirely different respects. First it is a very mobile and convenient form of energy whose utilization pervades all phases of industry, commerce, transportation, and agriculture. As such its increased availability will serve to expand these activities, acting as sort of lever or catalytic agent. Therefore, oil is not merely a desirable commodity, it is an economic force of the first magnitude. Standards of living are closely tied up with per capita consumption of oil.

The second way in which oil concerns Brazil lies in the possibility of finding and developing substantial oil fields within its own borders. This aspect is entirely apart from the matter of maximizing the utilization of oil, for which your requirements can be met from abroad. The development of domestic oil production adds a new dimension: it creates a new industry, increases the number of jobs, leads to the construction of roads, improves the exchange position in international trade, enlarges buying power and consumption, and in general brings about a net advance in a large number of wealth-creating factors. Therefore it is advantageous, especially in a developing country, for oil to be produced in sufficient quantity to stimulate domestic activities and provide a surplus for export.

The consuming and producing aspects of your interest in oil may serve to identify and emphasize a great principle which characterizes success in the development of a petroleum industry. Reference is had to the form of organization known as integration. In this type of economic arrangement, the functions of exploration, production, transportation, refining, and distribution are linked in a single, continuous process like an assembly line. Integration is essential as a pattern for the oil business for the reason that every step in the process from geological exploration to the delivery of products to the consumer is highly specialized, must be conducted in conformance with the liquid form of the substance, and cannot be carried on by the existing facilities of other industrial and commercial undertakings. Therefore, when free to develop, the oil industry tends to become a vertical enterprise, cutting across the stratifications of an economy and extending laterally beyond the confines of political frontiers.

Integration was a natural evolution in the petroleum industry. Such an end-point was inevitable because of the liquid nature of petroleum and the competitive urge for operating economies, which through a process of adaptation brought about the industrial pattern best suited to the job. The integrated form is revealed too in the corporate structure of the typical American oil company; and although a large number of units exist which operate in only one division of the business, these entities subsist and thrive in the network of the integrated pattern and, I believe, only by virtue of it. In a country of

advanced oil development such as the U. S., integration is a prime factor in promoting efficiency and cost-reduction, thus enabling the industry to serve the consumer with lower-cost products than would be possible without this arrangement.

In importing or exporting countries such as Brazil or Venezuela, integration offers an additional advantage by promoting the international flow of technology and capital, by bringing markets and supplies into closer contact, and by facilitating the movement of oil across political boundaries. Only organizations of international scope can possess the type of integration effective for these purposes. By its very nature, state enterprise cannot provide an equivalent. In consequence, no country seeking to promote oil production and consumption within its boundaries can afford to rely exclusively upon its detached efforts for the best results, irrespective of its competence in the field of industrial development generally. As soon as an oil problem transcends the geographic limits of the state—and what important problem in oil does not?—then its solution involves ipso facto the element of integration.

The development of the oil industry in Canada since 1947 was the result of favorable geologic conditions and the willingness of the government to grant prospecting and development rights to all qualified applicants. Here the principles necessary for the establishment of a competitive, integrated oil industry were recognized and approved and large markets were either available or could be established. In a word, the opportunity was present and incentives to vigorous effort were in action. It would be reasonable to expect Canada's production to match its consumption within ten years, that is, to be 400,000 barrels daily in 1958. The Prairie Provinces are now characterized by an oil boom second to none in the world today.

Difficult Problem

One cannot be equally assuring about the imminence of important oil developments in Brazil, although it has a large area of sediments in which oil may be found—more than 700,000 square miles, in fact. And this area may contain important oil resources. But there are many handicaps which much of the Canadian hunting ground does not possess. Brazil's geology is more obscure and much less known; the sedimentary basins for the most part appear to be quite thin, a serious handicap to major oil occurrence; much of the territory is covered by almost impenetrable jungle, or by extensive lava flows, or lies in country difficult of access; and the costs of exploration and transportation are extremely high. These considerations place the oil of Brazil in a less available position than is true for many other areas of the world. Accordingly more time, effort, capital and inducement must be provided for its development than otherwise would be necessary. Tens, if not hundreds, of millions of dollars and one, if not several, decades of time might be proper measure of what might be required to get the answer.

In the meantime oil products are available from the Caribbean area, because substantial refining capacity is in existence there and the European market for these products is shrinking under the impact of mounting shipments from the Middle East. Even though commodities must be exported in exchange for this imported oil, the process promotes the expansion of trade and creates purchasing power in the hands of your suppliers for increasing, in turn, your export markets. The most immediate objective is to facilitate the balanced growth of internal oil consumption to which end maximum utilization should be made of existing facilities, whether national or foreign. Such a policy will create, without sacrifice of growth in consumption, the time required to bring about adequate exploration for local sources of oil supply and under certain conditions even help provide the funds for financing the effort. And should full success in discovering local sources of oil supply fail to materialize or be long deferred, Brazil will find itself more closely linked to the integrated pattern of the international oil trade with the continuity of its external sources of supply better assured.

Misapprehension About Oil

At this point it is necessary to clear up a misapprehension about oil in the ground that widely prevails. It is generally believed that oil is liquid gold, bringing riches to those who go after it, and that the franchise to seek it is an extremely valuable privilege. As a matter of fact, oil is a very elusive substance, difficult to find, and interposing great risks in the way of its exploitation. In the U. S., the landowner is usually happy to assign the oil rights under his property to specialists for the consideration of retaining a one-eighth royalty. In Canada, there were several decades of fruitless and costly search, involving hundreds of wells and millions of dollars, before the discovery of the Leduc field provided the key to important results.

This misunderstanding regarding oil reserves indeed goes even deeper and involves the confusion of a mental image with a fact. Petroleum as we know it in commerce does not exist as such underground; what is present is a body of hydrocarbon material which can be converted into a marketable commodity only by a time-consuming process involving not only capital and technology but also a series of less tangible factors such as incentive, competition, political and economic climate, and many others. Thus oil in Brazil does not now exist (except the limited quantity already discovered); it can only be created by a touch of genius employing the accumulated technology of the ages and operating under a setting supporting the most persistent efforts. What you have underground in Brazil is merely "neutral stuff" or "starting material." Many steps must intervene before that becomes the "black gold."

The discussion now brings us to a consideration of another great principle that underlies the development of a dynamic oil industry. This principle is made up of two elements—incentive and competition. For example, there is a job to be done. It does not get done in a vacuum. There must be a reward for success and there must be rivalry. If the job is very big, very complex, and fraught with uncertainty as to whether it can be accomplished at all, then the inducement and the matching of wits must be proportionately great. Any form of organization must be set in motion by incentive, whether monetary, political, or merely an aspiration, but no type of organization can provide rivalry if it is alone in its field.

Adequate incentive and vigorous competition are peculiarly essential in the search for oil. Where competition has not operated, little oil has been found in the world—and much of that modicum may be attributed to the borrowed effects of competition operating elsewhere. Thus competition can exert a diminished influence across political boundaries even where its direct entrance is forbidden. This is why a monopolistic system can achieve results of a sort. But if competitive activity is deliberately sought and encouraged, then the

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THE DOWNWARD HYDRAULICKING ACTION of the fluid through the baffled, side down-whirler ports of a Baker Whirler Shoe, and through the nozzle-like bottom outlet, effectively removes bridges and permits safe running of the casing.

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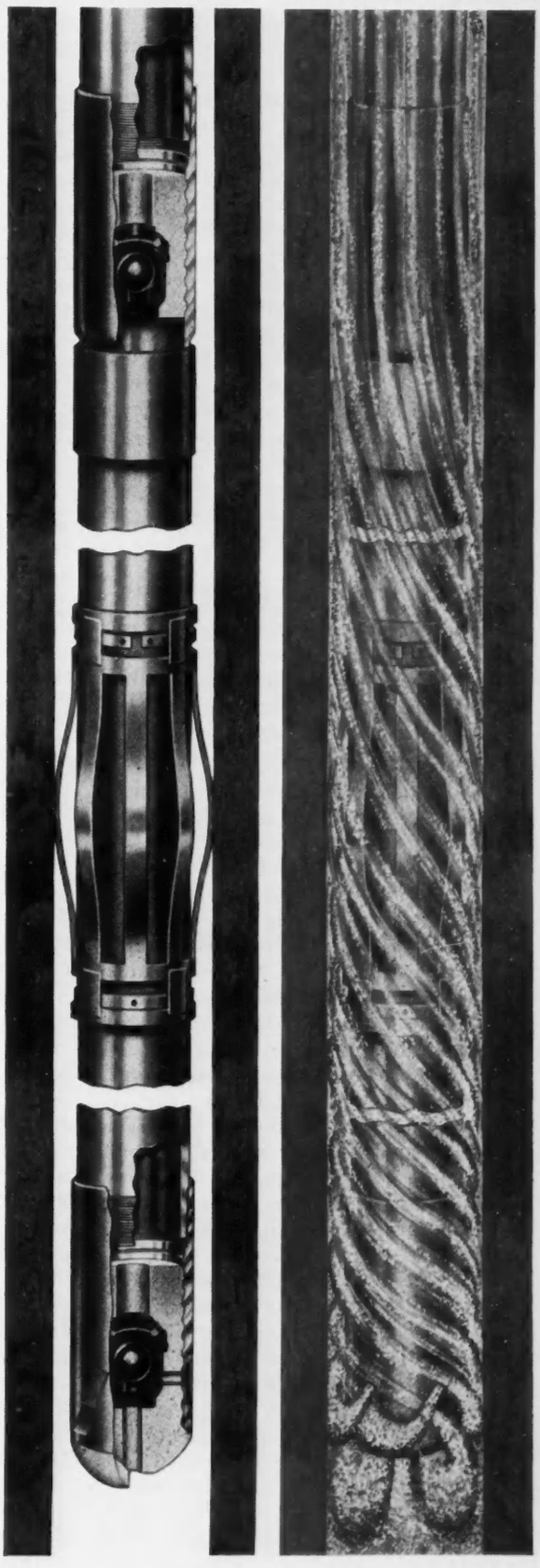

The view at far right shows the "whirling" motion given to the cement slurry as it is discharged from a Baker Cement Wash-Down WHIRLER Float Shoe, with the shoe joint centered by means of a Baker Model "G" Casing Centralizer. *This same whirling motion given to the circulating fluid, conditions and prepares the wall of the hole immediately prior to the discharge of the slurry.* The whirling action of the slurry, in turn, not only supplements the hole conditioning process, but also ensures that the centered casing will be completely encased with a uniform body of cement and that the hazard of channeling will be reduced to a minimum.

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KEY TO CEMENTING SUCCESS

great body of know-how accrued over the ages in the form of technology and embodied in the substance of capital becomes available as a dynamic power to make the most of any situation. And through the pattern of far-flung integration, the results of competition can be gathered from every quarter and brought to a focus on specific objectives.

Viewed as a whole, the oil business differs fundamentally from industry generally in that it requires a continuous and unbroken stream of new discoveries to enable it to maintain and increase the capacity to produce its essential raw material. If this is not done in a given consuming country, then that country becomes even more dependent upon the success of oil discoveries elsewhere and upon the promotion of those methods of economic organization best designed to achieve discovery results. No country can escape the international character of oil. Yet any country can retard its own progress and contribute to unsettlement elsewhere by failing to further the search for oil in terms of optimum endeavor.

Organizations For Developments

Oil has been discovered and developed in the world by three types of organizations: the individual enterpriser; the large business unit specializing in this field; and the national unit, or state.

Part of the success of oil developments in the U. S. is the result of conditions which encouraged the activity of thousands of individuals in the search for oil. This type of activity was rendered possible by the private ownership of the subsoil which gave rise to small leaseholds which in turn multiplied the subdivision of effort, spurred competition to a high pitch, and stimulated a great diversity of approach. Also, large business units have been no less active in the development of oil in the U. S. and, in fact, there has long existed a commingling of effort by the small and the large with great advantage to the economy. The single enterpriser contributed a unique vitality and diversification to the undertaking, while the large units brought the advantages of massive effort and integration to the problems of carry-through to the markets. As a result of the special contributions of each type, and the three-way competition engendered, the endeavors were transformed into outstanding levels of achievement.

Outside the U. S. conditions generally have not favored the small enterpriser. The task was too big and could not be subdivided sufficiently. The bulk of the achievements in this field has been made by the so-called international oil companies—massive aggregates of capital and technology, performing an integrated series of functions, and driven by a ceaseless urge to expand the production and utilization of oil. If experience is any guide, this form of organized effort represents the most direct avenue to achievement in this difficult field.

Many countries, however, have attempted to develop oil through the medium of an arm of the state. This centralized pattern involves the principle of monopoly and therefore excludes the factor of competition. The drive and force of the competitive type of enterprise are therefore lacking. The state operation, of course, has many proponents and has the advantage of conforming to the political aspirations of large segments of people. The results attained by this method, however, have not been conspicuously successful. Given time and the benefit of favorable evolution, its achievement may become more noteworthy, but as a system it possesses certain inherent mechanical and economic drawbacks which, irrespective of the knowledge and skill of the managerial personnel, can be overcome with difficulty, if at all. It is slow in application and therefore "wastes" that invaluable ingredient, time; it must be subsidized out of the internal economy itself; and it lacks integration across the country's borders which limits the channelling of surplus production from sources to markets.

Now to clear up one more misapprehension. It has to do with the status of national control under governmental versus private operation. The confusion on this point is widespread. A nation does not lose control of its resources when they are granted under concessions to private enterprise, whether domestic or foreign, for development. The power of the sovereign is still supreme. A concession is merely an instrument designed to induce enterprisers, operating within the framework of the laws of economics and the terms of the agreement, to convert starting material into finished, commercial products. It is important, however, that the arrangements be fair and in conformance with the business risks; and in the event of success following the investment of capital, technology, time, and energy, there should be assurance on the one hand, and confidence on the other, that the rules shall not then be changed to the disadvantage of the undertaking. In those instances where summary action has been taken by a resource country in violation of long-standing agreements, and sufficient time has elapsed to provide a record, the results have proven disadvantageous. There is always present the philosophy that it is a bad thing to have "profits" from operations going to anybody but the nation's government; and that it is particularly shocking if these profits go to foreigners, even when the foreigners have put up the capital and assumed the risks. This philosophy stems from failure to appreciate the great advantages that accrue to a nation from the contributions that outsiders can make to the economy. The free flow of capital and technology across political frontiers is perhaps the greatest consummation to be wished for in these troublous times, short of peace—and to the attainment of a peaceful world a greater economic contribution could scarcely be made than in this manner.

Pemex To Drill Wildcat In Northeastern Mexico

Petroleos Mexicanos, the Mexican government oil monopoly, is moving equipment into Northeastern Mexico to drill a wildcat 38 miles from Nuevo Laredo, across the Rio Grande River from Laredo, Texas. The location is about three miles west of the Pan-American highway from Laredo to Mexico City, on the La Escalera Ranch.

Another wildcat, El Toro 1, drilled 12 miles south of Nuevo Laredo recently, was abandoned as dry at 2500 feet.

Meanwhile, CIMA (Mexican-American Independent Company) is having negative results in its drilling campaign near Vera Cruz, on the Caribbean Gulf. As a result of continued failures in drilling, three of the top CIMA officials in Mexico City have resigned and returned to the U. S. The resignations are thought to be the forerunner to curtailment of CIMA's operations in the republic. The company retrenchment in personnel followed the abandonment of Tortuguero 10, CIMA's last test in that field.

Oil Sought in Greece

Likelihood of oil-bearing strata in North Central and Northeastern Greece was reported by the Greek Service of Geological Investigation, working with the Economic Cooperation Administration. Completion of the exploration program will require the expenditure of about $2 million.

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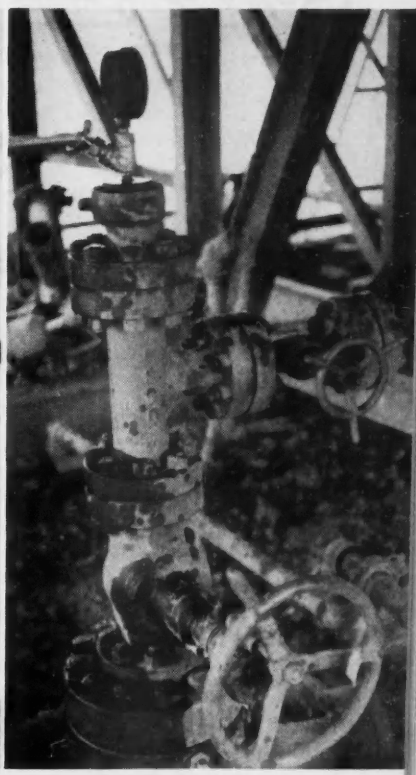

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Report from Austria:

Soviets Will Strip Fields Before Treaty Is Signed

AUSTRIA could export 3,400,000 barrels of oil products annually and could still cover the 2,784,000-barrel needs of its citizens, if the Soviets, who have commandeered the fields, would release them to the Austrians.

Beginning in 1930, U. S., British, Swiss, and Netherlands companies explored for oil in Austria and had achieved Europe's second largest output by 1938 with 4,750,000 barrels annually (Roumania was first with its 29.5 million barrels).

Located in the eastern province of Lower Austria (Niederoesterreich), the Zistersdorf fields have about 500 wells producing oil from an average depth of 200 feet.

The postwar Austrian annual requirement of 2,380,000 barrels was entirely covered by indigenous sources, but special oils, antifreeze, brake fluids, technical oils, and grease always had to be imported at an annual cost to Austria of $3 million.

These imports could be made good and a small profit established, but for the present Soviet monopoly, by exporting the remaining oil to Hungary, Czechoslovakia, and Italy.

When Hitler took over Austria in 1938, the oil fields were enlarged, and forced production began. By using open flow valves and compressed air for a speedup output, the annual rate of 4,750,000 barrels was boosted to 8,150,000 barrels in 1944.

The Soviet Red Army entered Austria in early April, 1945, and occupied the oil field. After dismantling machinery worth $25 million for shipment to Russia or its satellites, they started production for the Red Army's needs with the remaining equipment. The Soviets had removed, among other, smaller material, 35 percent of the compressors, 74 percent of the pump installations, 75 percent of the diesel engines, and 85 percent of the drilling equipment.

With the machinery left, the Soviets produced in 1945 44,200 barrels monthly. But they soon raised the output, and in 1947 the monthly production reached 523,000 barrels, of which the Red Army received a small part, while the bulk was shipped to the eastern countries.

The Nazi policy of forced production was continued by the Soviets, and the Zistersdorf fields, estimated to yield 54,300,000 barrels, are now expected to be depleted in five to seven years.

Since 1945, the Soviets have directed oil production as a monopoly in their zone, and all prospecting, drilling, and refining, as well as delivery and price policy are entirely in the hands of the Soviet Mineral Oil Administration (SMOA), the Austrian office of the Socialistic Soviet Ministry of Naphtha, headquartered in Moscow.

While the Russians thus found a profitable source of supply and revenue in their zone, the U. S. Army found only one small oil field in the Province of Upper Austria (Oberoesterreich) and a small, 2500-barrel refinery in the same province. The others, the British and the French forces, did not find any oil or oil-refining units at all in their zones.

Soviets Sit Tight

The Soviets, soon realizing the value of the oil fields, refused any discussion on this subject. While the Western Allies tried to make the Bolsheviks agree on a status of "inappropriate for reparations" for the oil fields, because the original owners were nationals, the Russians refused to consider this subject.

In the same way, the Austrian government was unsuccessful in persuading the Soviets to hand the oil fields over to Austrian trusteeship, as the Western Allies had done with all German assets in their zones.

The Soviets, however, offered Austria a 50-50 split of production and profits, if it would sign an agreement concerning this combined production. The Austrians, unwilling to legalize the Soviet claim to the oil fields, and unable to say anything without the approval of the underlying lease owners, as well as the German investors in expansion, refused to sign the statement, and were openly acclaimed for this decision by the High Commissioners of the Western Powers.

The Soviets continued to produce oil and, in 1947, distributed 70 percent of the oil for their own use and that of the Soviet satellites, while only 30 percent went into Austrian hands.

Claiming the oil fields as German assets, and quoting President Truman's agreement on this matter insistently (President Truman agreed at the Potsdam Conference in August 1945, that all German assets in the Eastern Zones of Germany and Austria, and in Bulgaria, Finland, and Hungary, should be made over to Soviet ownership), the Soviets are determined not to include the Zistersdorf fields in the group of 330 industrial and 140 agricultural units which are to be returned to the Austrians after a state treaty, and after the payment of $150 million to the Bolsheviks. They are set on retaining sole ownership of the field until depletion.

Production since 1947 has been in-

TABLE 1

	Gasoline	Special Gasoline	Kerosine	Diesel Oil	Fuel Oil	Lube Oil	Bitumen
Internal Production	81,250	6,412	27,000	139,855	228,000	37,300	15,600
Imports	39,897	3,122	.....	16,750	.....	2,674	3,557
Total	121,147	9,534	27,000	156,605	228,000	39,974	19,157
Contrasted with 1949							
Increase	18.6%	227%	.....	39%	133%	.....	.....
Decrease	.....	.....	40%	.....	.....	47%	19.2%

creased by exploration and by forced production of a new field at Matzen, near Vienna. Here the Soviets have exercised their self-bestowed right of monopoly to exploration and drilling in any locality in their zone.

Newest information from usually accurate sources in Vienna puts 1950 Austrian crude production at 10,200,000 barrels. While the Soviets officially stated the production for 1950 to be only 6,790,000 barrels (one-third less), and declared the delivery of 2,380,000 barrels as 28.5 percent of the whole Zistersdorf oil field's output, the rise in the distribution of oil products in 1950 to 3,640,000 barrels is, in relation to the 10,200,000 barrel total, still below the 28 percent mark.

Crude and refined products delivered to the Red Army and the Soviet satellites amount to almost 6,790,000 barrels, or two-thirds of the production.

The loss to Austria in 1950 by exporting this crude and refined products without reimbursement to the Austrians is said to be at least double the $21.35 million loss of 1947. The higher amount and the increased world market prices for oil products are the reasons.

An activity having no connection at all with the Potsdam Agreement, with President Truman's statement, or German assets, is the Soviet order from the beginning of the occupation for a widespread search for new oil fields. These explorations discovered the Matzen field, which is estimated capable of a 544,000 barrel annual output for about 12 years. Now, however, a year after the first drilling, production is said to have hit the 680,000-barrel limit, and specialists stated recently that this field will be depleted in about half the originally expected time.

As to monopoly, all the refineries except one are in the hands of SMOA. Its seven plants are capable of turning out an annual 5,710,000 barrels of medium-grade products, or a lesser amount of higher-grade ones.

All delivery facilities, too, are in Bolshevik hands. An Austro-Soviet company (OROP), handles all delivery and maintains all filling stations in the Eastern Zone. The cooperation with the Austrian government is confined to the order to deliver certain amounts to certain stations monthly, while any other control is beyond Austrian power. The filling stations in the Soviet Zone offer only Zistersdorf gasoline, but rarely mixed with imported, better grade fuel. Engine lubricants are sold by OROP in only three SAE types: for winter, changing-weather periods, and summer. The owners of filling stations have to accept the Russian gas and oil—or none at all.

Delivery of Zistersdorf oil to the western Austrian zones is very small, although the official relation and mixture is set at 50-50. In by far the most cases, though, the mixture (if mixed at all) is 85 percent imported to 15 percent Zistersdorf gasoline in the western zones, and almost pure Zistersdorf (65 to 72 octane) gasoline in the Soviet Zone.

As far as the Autrian minimum requirements go, the figure is set by the government. It takes care of a steady supply for the most important consumers (industry, food, transport, doctors, newspapers), and allows private car owners a small amount of gasoline for private use. While the ration is 5 to 50 gallons of gasoline monthly for the more important vehicles, and 2 to 20 gallons for private drivers, diesel-driven vehicles receive from 10 to 100 gallons, and 5 to 50 gallons respectively.

Prices were set in 1945 at 1.30 schillings (13 cents) per liter (about one

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quart), at an official schilling-dollar relation of 10:1, and a black market rate of 80 up to 120:1. In 1946, the Soviets deliberately raised the price to 1.85 and in 1949 to 2 schillings (20 cents) per liter. In 1949, however, a new relation between the schilling and the dollar was established officially at 26:1, and the black market price fell to almost the same rate. The Austrian government had to increase the gas price in late 1949 an additional half schilling (2 cents) per liter.

While the increases in price by the Soviets had been inaugurated merely to make a larger profit from the oil fields, the Austrian government had to institute its 1949 raise to cover the $12 million annual bill for oil imports, at least partly. This 50 groschen charge (1 schilling equals 100 groschen) has to be paid when the gasoline coupons are picked up at the district offices. Sometimes, when the Soviet deliveries are low, more of such "to-be-paid-for" tickets must be purchased, while 10 to 60 percent of the monthly ration is free. All coupons must be turned in to gas stations by consumers, and the uniform price of 2 schillings per liter paid for the fuel. At times of increased Soviet delivery (or when the Soviets deliver a three-month quota all at once, after being in arrears all during that period) the amount of such import-tax-paid tickets is lowered from 90 to 40 percent.

The postwar imports of special oils, gasoline, and grease have to be maintained in the amount of $3 million. But in addition, about one-third of the gasoline needs, half of the minimum requirements of special gasoline, 12 percent of the diesel fuel, and 20 percent of the bitumen requirements must be imported, although these products are produced in Austria, but are not available to its citizens. Here the $12 million expense is incurred.

Once these facts are established, the data on Russian production, delivery, and handling methods acquire special interest.

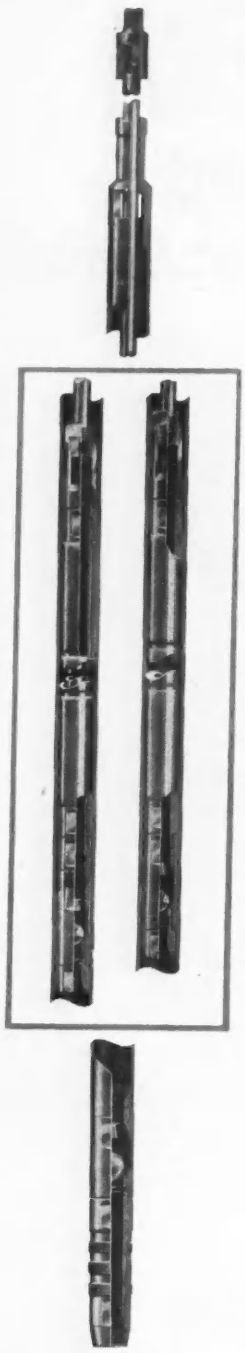
From the 1947 production of 6,300,000 barrels, the Soviets "exported" from the oil field 1,705,000 barrels of crude. The remaining 4,560,000 barrels were shipped to the seven refineries in the Vienna area, and after a refining loss of 10 percent, 2,480,000 barrels were distributed to the Austrians, while 1,753,000 barrels were sent to Eastern Germany, Czechoslovakia, and Poland, and part was used by the Red Occupation Army in the eastern Austrian provinces. This distribution breakdown indicates that 27 percent of the crude and 43 percent of the refined oil products were withheld by the Soviet Mineral Oil Administration, the Austrian office of the Soviet Ministry of Naphtha Administration.

The loss from this withheld percentage reached, in that same period, $21,350,000. Allowing a deduction of $2,645,000 for special grade gasoline and lubricants, technical oils and grease, damage of $18,705,000 is incurred annually by Austria, which has to be supported by the Marshall Plan to the extent of about $200 million annually. Besides this loss in hard-currency income, Austria has to pay $12 million per year for the above-mentioned imports.

Nationals Suffer

Under these conditions, the continuance of the wartime rationing system had to be maintained. Austrian industry and the motorist not only are handicapped by the highest gasoline prices in Central Europe (58 cents per U. S. gallon) but it has the smallest gasoline ration per citizen in the same area.

The Soviets are knowingly making use of this shortage of fuel and deliver voluntarily more gasoline to the filling stations than the Austrian distribution plan calls for. Anything above



don't be satisfied with "just a pump"

Harbison-Fischer Precision and Tuff-Temper Rod Pumps are the finest full-barrel, metal-to-metal type insert pumps made . . . *yet they sell for the same price as pumps of lesser quality.* The Precision (left) has a composite type plunger of 12″ sections, perfectly aligned to work in a close fit in a straight and uniformly accurate seamless steel barrel tube (also furnished with chromium plated plunger). Heat-hardened plungers and chromium-plated barrel tubes are available for abrasive and/or corrosive fluids. Tuff-Temper Rod Pumps have a one-piece plunger heavily plated with hard chromium, and grooved at intervals for a better fluid seal and to trap sand or scale particles. The one-piece barrel tube is heat-treated by our exclusive electronic process which creates a hard inner surface, but allows the outer wall to remain ductile and shock resisting. Both pumps conform fully with A.P.I. sizes and standards, and parts of one pump are interchangeable with the other. Complete assemblies are available in either top- or bottom-hold-down types, with single or double valves, in stationary or traveling barrel styles, in a wide range of barrel lengths, and in 1 1/16″, 1¼″ and 1½″ sizes for 2″ tubing and in 2″ size for 2½″ tubing. H-F pumps and related equipment are sold from stock by leading supply stores in all major producing areas.

Precision **TUFF-TEMPER**

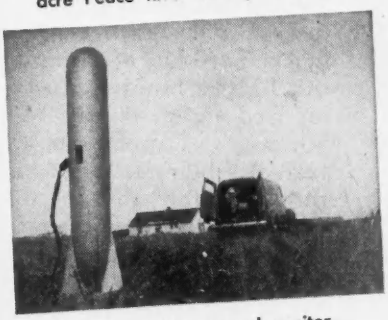
—for less down-well down-time . . .

Harbison-Fischer Sub-Surface Pumps

Little was known of the regional geology when big 16,000,000 acre Peace River Survey began.

No maps existed for some areas, so photo flight maps were made to guide the swift survey plane.

Rugged terrain (boggy muskeg, heavily timbered areas) did not slow the survey's progress.



A highly sensitive ground monitoring station checked constantly for any magnetic storms.

Air data and ground positions were tied together with continuous record of flight path.

Aeromagnetic data was compiled in precise map form at the rate of 2,000,000 acres per month.

This survey problem was 16,000,000 ACRES BIG

When the Alberta play began to trend north, not much was known about this big, rugged area. Here, muskeg and heavily timbered areas make ground studies slow, difficult and costly.

But with the airborne magnetometer, Canadian Aero delivered important data about the regional geology at a fraction of the time and cost of ground studies. Survey flights were started on this 16,000,000 acre area in May 1950, and within three months, the flying was completed. This reconnaissance for the four participating companies* is only a part of the more than 250,000 miles of aeromagnetic surveys made by Aero and Canadian Aero.

In addition to the large-scale reconnaissance surveys, Aero and its affiliate are equipped for smaller magnetic studies anywhere in the world. For more information about costs, schedules, accuracies, write today. Let us tell you why our surveys are the most precise ever made.

* *for Socony Vacuum Exploration Co., Stanolind Oil & Gas Co., Imperial Oil, Ltd., and Canadian Gulf Oil Co.*

TOPOGRAPHIC MAPS • PLANIMETRIC MAPS

PRECISE AERIAL MOSAICS • AIRBORNE MAGNETOMETER SURVEYS

RELIEF MODELS • COLOR PHOTOGRAPHY

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the official amount is to be sold on the gray market, from which the Bolsheviks are collecting the profits. The gray market prices in the Soviet Zone are from 50 to 150 percent higher than the official price, and almost any vehicle-sized quantity is currently delivered. Sometimes filling stations, which at best make only a very small margin of profit, sell official gasoline without coupons or tickets to customers, but at the higher price. Severe punishment has been the lot of those caught when they were unable to produce coupons for return to the government agency after having sold the fuel. Some counterfeiting of coupons has occurred, of course, but not to a dangerous extent.

In the Western Zones the Soviet gray market does not exist. There the black market of the individual owners of the filling stations operates, and the fuel is sold without coupons, at a 100 to 350 percent higher price. On a smaller scale, too, stolen or misused gasoline from some foreign agencies is sold, mostly privately, and the prices for the best grade fuel are even higher.

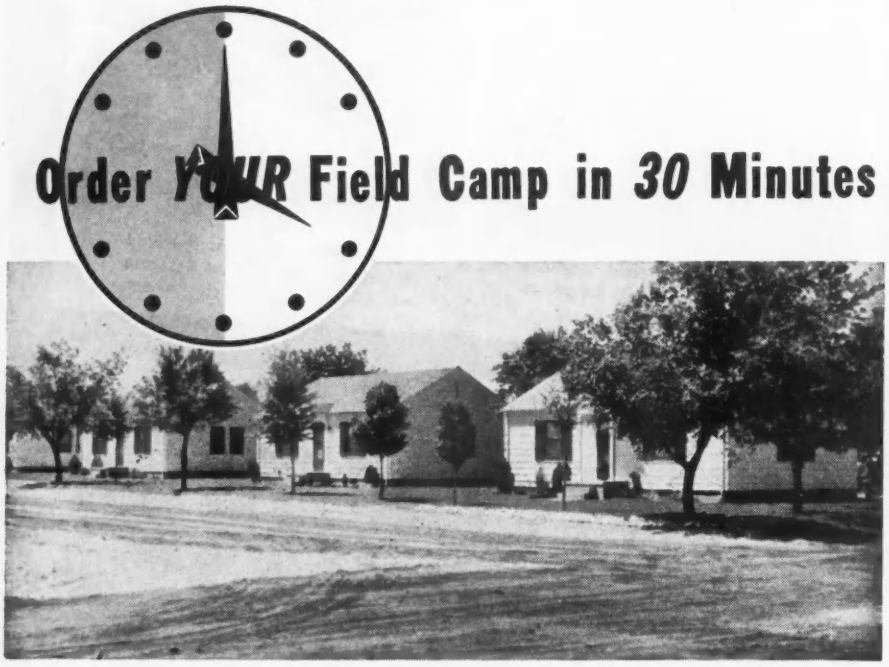
While the shortage of gasoline is still constant, it has been possible to remove rationing from diesel fuel, kerosine, and the engine oils, although imports are still necessary within these groups, also. Still rationed are gasoline, special gasoline (benzol), fuel oil, and bitumen.

Table 1 shows the different groups of oil products, as delivered by order of the Austrian Federal Ministry for Trade and Reconstruction, showing both the indigenous and the imported totals necessary during the year 1950 in tons.

The increase in deliveries of gasoline, special gasoline, diesel fuel, and fuel oil is, as experts claim, not so much based on a changed policy of the SMOA toward Austria, but is founded rather on the order of the Soviet government to increase the intake of schillings. With this currency the Soviets are able to purchase raw material, foods, and readymade goods —anything from aluminum to steel, from magnesite to nitramoncal, from grain to electric machinery, tractors, and items which often appear on the western embargo lists. Such lists are without much effect in Austria, where armed representatives of the opposing ideologies in the cold war meet.

Such purchases, however, cause other damage to the Austrian economy. Soviet-controlled oil is a weapon for oppression and blackmail of the Austrian government to force abundant supply of the USIA factories. (USIA-Administration of Soviet Property in Austria, the much-discussed "German Assets.") It further brings pressure to bear on the workers through their workers' union. Oil is the chief buy-and-sell item with the Soviets, and not only in Austria. Austrian oil is known to be offered in the Soviet satellite countries, such as Poland, Eastern Germany, and Czechoslovakia. In Hungary, the Soviets have established the Meenhart Company, something similar to the SMOA in Austria, but on a smaller scale.

As far as the first draft of the Austrian State Treaty has been made public it does not include the return to Austria of the Zistersdorf oil fields. They are not supposed to fall under the category of properties which Austria is invited to buy back for $150 million, one-sixth of its annual federal budget. The Soviets have up to now succeeded in avoiding any decisions being promulgated on the oil question. In five to seven years, if the fields are empty, as specialists fear, the Austrians might be allowed to buy them back.



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In a half hour you can choose the STURDYBILT, prefabricated, demountable houses you want, place the order, and know your camp will be ready when you want it. Homes, warehouses, tool houses, garages and bunk houses have been designed to suit your needs, and are ready for your selection.

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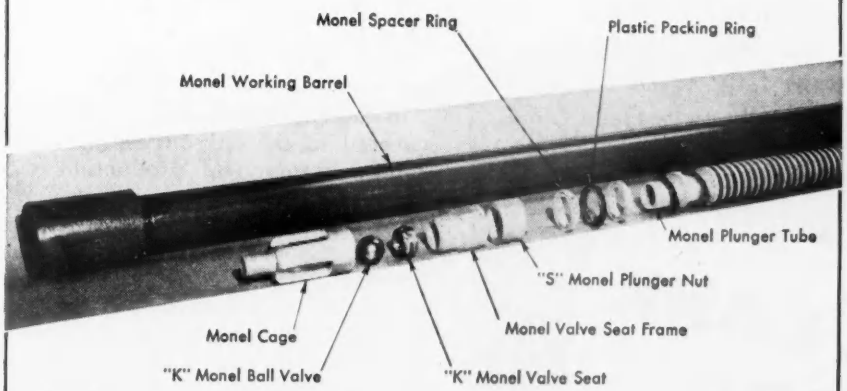
Two metals have proved...

CORROSION CAN BE CONTROLLED

...even in SOUR CRUDE wells!

A SWEET PUMP FOR SOUR CRUDES. With working barrel and principal plunger assembly parts made of Monel and "K" Monel, many pumps of this type have demonstrated their capacity for long, productive runs in corrosive media. Records of 18 months and more have been reported from fields where the life of pumps is ordinarily measured in days.



AN "EXPLODED" VIEW of the Harbison-Fischer Pump pictured above, showing its various Monel and "K" Monel parts. Their resistance to corrosion, abrasion, erosion and fatigue is reflected in improved performance and extended pump life. *Photo courtesy of Harbison-Fischer Manufacturing Co., Fort Worth 1, Texas.*

High sulfur crudes – like those found in west Texas and New Mexico—are trouble-makers.

Yet a good many corrosive wells in these areas are being operated *without excessive downtime and production losses.*

How? With equipment made wholly or in part of high-Nickel alloys. MONEL®, for example. And "K"® MONEL.

Both metals offer protection against severe oil field conditions. They resist corrosion by brines, weak acids and hydrogen sulfide. They withstand stress, vibration and wear. They resist the cutting action of high-pressure gas... and provide exceptionally good resistance to abrasion and erosion by entrained solids over wide ranges of temperatures, pressure and velocity.

Because of these characteristics, Monel and "K" Monel are extensively used for parts subject to alternating stresses in the presence of corrosives. Their retention of good fatigue strength pays off in lengthened equipment life.

"K" Monel usually gets the nod when there's need for a part with certain *extras.* For one thing, "K" Monel is *non-magnetic.* For another, it is *heat-treatable;* its tensile strength can be developed to 140-170,000 psi, and its hardness to 265-320 Brinell. Yet it can be readily formed, machined and welded prior to the heat treatment that develops this extra strength and hardness.

The full story of what Monel, "K" Monel and other INCO Nickel Alloys can do toward reducing oil field problems is contained in our illustrated booklet, *Controlling Corrosion in Petroleum Production Equipment.*

Here you find typical performance and service stories of Nickel Alloys in a variety of corrosive uses. Individual sections deal with exploration and drilling, pumping, and gas control.

Because of the demands of the national rearmament and defense program, we can't promise that you'll be able to get all the INCO Nickel Alloy equipment you'd like to have. But *Controlling Corrosion in Petroleum Production Equipment* will tell how you can obtain technical assistance on problems involving metals for oil field use. And it contains a listing of valuable bulletins that are available to you on request. Write us for your free copy of this helpful booklet—*now.*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

INCO

MONEL "K" MONEL

...YOUR PARTNERS IN PROGRESS

Venezuelan Labor Contract Sends Costs to New High

A new labor contract boosting Venezuela's already high labor costs by an estimated 10 percent was signed in Caracas. Labor representatives had in effect torn up the expired contract which had governed relations since 1948, and presented a set of nearly 150 new and separate demands.

The industry, estimating the cost of compliance at an additional $1 billion a year, refused to negotiate on this basis, and proposed a more reasonable modification of the old contract. Though it was pointed out that the average annual value of all exports from Venezuela, including petroleum, is only slightly over $1 billion, while the national budget is somewhat less, the groups representing the workers refused to back down.

At this point the federal government intervened to break the stalemate, and by decree forced the acceptance of a compromise. The new terms, effective for the next 30 months, will cost the companies an estimated $300 million a year over what was previously paid. New benefits are both direct and indirect, ranging from a 66-cent increase in the basic daily wage to the freezing of prices of staples in company-operated commissaries at 1948 levels.

The Venezuelan oil worker was already one of the highest paid in the world before the new contract was signed, drawing about $10 a day in take-home pay and $5 in social benefits such as housing, hospitalization, savings plans, etc. Considerable concern is being felt in Venezuela that labor's persistence in laying such a payroll burden on the companies may eventually result in pricing Venezuela oil out of the market.

FIRST IN CANADA'S OIL FIELDS

Assets exceed $2,497,000,000

Branches throughout Canada's oil-rich western plains. On-the-spot information available through J. C. Mayne, Supervisor, Calgary, Alberta, or Head Office, Montreal

THE ROYAL BANK OF CANADA

Over 750 branches in Canada and abroad

Tehuantepec Discovery Well Brightens Mexico's Outlook

Major encouragement was given for the future oil development of Mexico's Isthmus of Tehuantepec with the discovery of Petroleos Mexicano's Jose Colomo 1, state of Tabasco. At 5200 feet, the closed-in bottom hole pressure of the well was 2215 pounds per square inch, and through a 7/16 inch choke, production averaged 1900 barrels daily, flowing for 48 hours.

The structure tested is tentatively classed as a broad uplift with an almost east-west axis extending about eight miles, with the east and west sides dropping about 250 feet from the crest, while the northern and southern flanks fall off a minimum of 2000 feet. The well was completed in the "Upper Amate" sand of the upper part of the Lower Miocene, which it entered at about 4200 feet.

The northern area of the isthmus, where the Jose Colomo 1 is located has long been recognized as a petroliferous zone, but full exploration and exploitation were prevented by topographical conditions and limited geophysical and drilling equipment. The location of the Jose Colomo 1 was, in fact, chosen largely because of its accessibility by water, inasmuch as there are few roads or navigable rivers in the area.

Although several fields were discovered in the isthmus in the early 1900's, commercial production was confined to the saline basin of Veracruz, the most accessible and easily drilled region. During the 25 years preceding 1925, when the Filisola field in the saline basin was brought in, eight isthmus fields produced only 2½ million barrels, and total production for 1925 was only 271,000 barrels. Tonala and El Burro fields came in in 1928 and 1930, and El Plan started producing in December, 1931. These four salt domes have accounted for 96 percent of the 169 million barrels produced to date in the isthmus.

PROVEN Through Extensive Use in the PERMIAN BASIN

For HYDRAFRAC JOBS

For ACIDIZING

For DUAL COMPLETIONS

For GAS or WATER INJECTIONS

SOLD THRU SUPPLY STORES

THE

WILSON

TYPE "MB"

Metal Block

PACKER

—with HOLD-DOWN—

Here is a combination tool that is really getting the job done in West Texas.

For Hydrafrac Operations, Acidizing, Dual Completions and Gas or Water Injections—the Wilson Type "MB," Metal Block Packer, with Hold-Down is proving to be in a class by itself in giving satisfactory service under most difficult conditions.

The Wilson Type "MB" Packer, with Hold-Down is Full Opening. It will *hold*, regardless of how low the well is swabbed, as it will hold a high differential from underneath, assuring an efficient Acidizing or Hydrafrac job.

This Tool is *SOLD*, not rented, therefore it is not necessary to kill your well after completing job.

To pull packer it is only necessary to equalize tubing and casing pressure. The Hold-Down slips cannot lock against the casing because the taper on the slip cone is pulled away from the slips as the tubing is raised.

The Wilson Type "MB" Packer cannot *Cold Flow*, regardless of how great the Hydrostatic Head.

This is an outstanding development in Packer design and construction. It will save you time and money to run the Wilson Type "MB," Metal Block, Packer, with Hold-Down.

WRITE

WILSON FOUNDRY & MACHINE CO.

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HOUSTON, TEXAS

Plant Finished in Scottish Oil Expansion Program

An important addition to Great Britain's program of home oil refinery construction will be the completion of a crude distillation plant at Grangemouth, Scotland, which is now being tested and prepared for operation. The plant is owned by Scottish Oils, Ltd., a company of the Anglo-Iranian Oil Company, Ltd., group.

The construction is part of a £17½ million ($52 million) expansion program of Anglo-Iranian in Scotland. Besides the Grangemouth refinery reconstruction, the group is building a crude pipe line across Scotland from west to east, and in conjunction with The Distillers Company and Monsanto Chemical Company, a plant for the production of chemicals from petroleum at an adjacent site.

The pipe line will raise throughput capacity of the Grangemouth refinery to 1,800,000 tons annually (37,700 barrels daily), triple its present output and compared with prewar throughput of 360,000 tons a year (7,500 barrels a day).

The new pipe line will give access to a deep water harbor in Loch Long, where a new unloading terminal is being built at Finnart.

WORLD OIL Names International Editor

DONALD E. KLIEWER has been appointed WORLD OIL's International Editor, which completes an editorial realignment designed to place each section of the magazine under the direction of a specialist in that branch of the industry.

Kliewer, born and reared in the oil fields, attended grammar school at Ranger, Texas, high school at Longview, Texas, and was graduated from the University of Texas in 1941, meanwhile filling his vacation periods as gauger, tool dresser, pipe-liner and roustabout. He was telegraph editor of The Paris (Texas) *News* and Galveston *News* and *Tribune* before entering the army in 1942 for a three-year stint, of which 16 months were spent in Puerto Rico, where he taught English, history and geography to native soldiers. He rejoined The Paris *News* as a reporter in 1946, and subsequently was managing editor of The Hillsboro *Mirror*, and city editor, then news editor, of The Galveston *News*. He went to The Houston *Post* in 1948 as a copy reader, was later make-up editor, and was assistant news editor when he resigned to join WORLD OIL.

Kliewer succeeds Mark Olson, now general manager for C. J. Brown, Houston independent oil operator.

Syria Project Abandoned After Long Quest for Oil

Syria Petroleum Company, Ltd., associated with Iraq Petroleum Company, Ltd., has informed the Syrian government that it will discontinue all activities and close its offices within six months. The company is retaining until 1954 a small area in Upper Djezira, near the Iraq frontier.

Syria Petroleum failed to find commercial production after a prolonged exploratory effort costing about $17 million. The firm drilled 11 wells for a total footage of approximately 85,000 since the concession was granted in 1938.

All-Purpose Tankers Being Built Under Shell Program

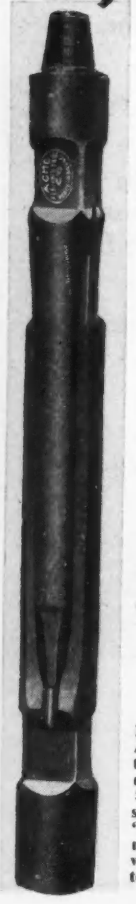
The largest tanker-building program since the war is being conducted by Shell at a cost of approximately $130 million, it was announced in London by Sir George Legh-Jones, M.B.E., managing director of the Anglo-Saxon Petroleum Company.

The program consists of tankers specially designed to carry over ocean routes the Shell Group's oil trade and provides for 41 general purpose tankers of 18,000 tons deadweight of entirely new design and five supertankers of 28,000 tons deadweight—a total of nearly 900,000 tons (d.w.) of new construction. This single program is approximately equal to the total tonnage owned by the Shell Group in 1930.

Berths for 31 of these vessels have been booked with U.K. yards and for 15 yards in the Netherlands. Deliveries will begin next year and the program is expected to be completed by the end of 1955.

The new 18,000-ton tanker introduces a general purpose type vessel capable of trading to ports covering more than 80 percent of Shell's worldwide trade.

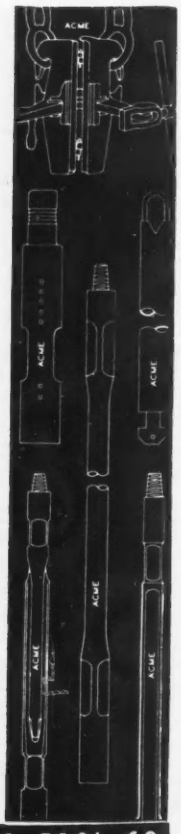
"The Greatest Name in Cable Tools..."



Acme

TRUSTWORTHY SINCE 1900

PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION MEMBER



. . . to-be-Sure—Always Ask for Acme's Welded Jars . . .

In the Rein-type Welded Jar category, Acme's drill most hole per jar-dollar; making them your choicest, TRUSTWORTHY buy... Why: Acme's Jar and capping steel specifications are SO rigid—allowing only a 5-point range (not the mills' usual 10) that we pay EXTRA. Assuring you premium-grade steel protection down hole.

Every forging's uniformity electrically controlled; automatically shutting off at CORRECT point. No "burning" possible. Such Acme vigilance is your greatest assurance—of EXTRA inner-Jar qualities. Born of a ½-century's specialized experience and carried on by "Old School" Jarmakers whose workmanship cannot be "stop watch" limited.

See Acme's Insert in 1951 Composite Catalog. Also write for more complete Catalog, containing valuable cable tool "use and care" manual.

Fig. 107 — Acme Rein-type Welded Jars. 51-years' specialized "know-how" makes them worth more to YOU.

ACME DRILLING & FISHING TOOLS

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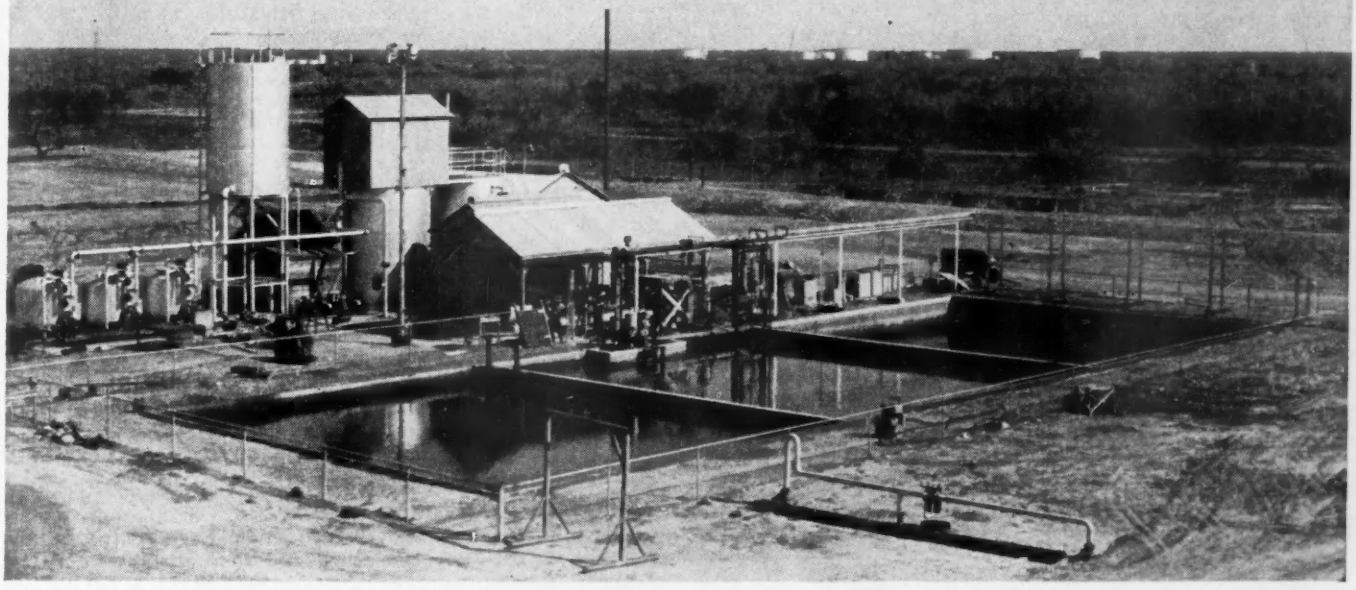
How To Get Full Capacity From Your Salt Water Disposal Wells!



DISPOSAL PLANT LAYOUT, MAGNOLIA PETROLEUM CO., PREMONT, TEXAS

YOU can get maximum capacity and satisfaction from your salt water disposal wells only if you maintain the ability of the formation to receive the water. The way to do that is by treating salt waters with Infilco equipment.

REMOVES SUSPENDED MATTER *by coagulation and filtration.*
STABILIZES THE WATER *to prevent scaling.*
CONTROLS CORROSION *to prevent production of insoluble products.*
STERILIZES *to prevent growth of bacterial gel on the formation face.*
PROVIDES FREEDOM FROM DISSOLVED SUBSTANCES *that would react with the reservoir water to produce a precipitate in the formation.*

Infilco installations from coast-to-coast are treating over ONE BILLION GALLONS of water *every day!* Call in the nearest Infilco Field Engineer or write our executive offices in Tucson for equipment recommendations.

SERVING THE OIL INDUSTRY WITH WATER CONDITIONING EQUIPMENT THAT'S

Quality Engineered for Quality Performance

INFILCO
BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894

INFILCO INC.
TUCSON, ARIZONA
WITH OFFICES IN PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

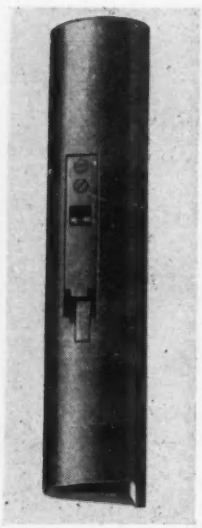
NEW AND IMPROVED EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

External Cutter

This item supplements McCullough Tool Company data on pages 3205-3244 of Composite Catalog, 18th Edition.

A new thin wall external cutter permits external recovery of drill pipe, casing and tubing in tight holes. It is for use only where standard cutters cannot be used, due to extremely small clearances between the pipe and casing, or between joints and the wall of the drilled hole in an oil well.



Because all operating parts of the cutting mechanism are contained in the wall of the cutter, a minimum wall thickness of only 7/16 inch is made possible. No parts protrude inwardly or outwardly while going into the hole.

In operation, the cut is first positioned under a tool joint or coupling. This is accomplished by pulling the cutter up, until the trip lugs contact the lower shoulder of the tool joint, coupling, or external upset. Upward strain is continued until the shear pins that hold the knives within the cutter wall are tripped. The cutter is then lowered sufficiently to relieve any excess load on the knives. As rotation is started, the cutter is pulled slowly upward, until the lugs again contact the shoulder. Then an occasional upward movement as the cutter continues to rotate forces the knives inward, severing the drill pipe, casing or tubing. The cut-off section is then carried out of the hole by the cutter.

The thin wall external cutters are made only on special order.

For additional information, write McCullough Tool Company, 5820 South Alameda Street, Los Angeles 58.

Well Servicing Hoist

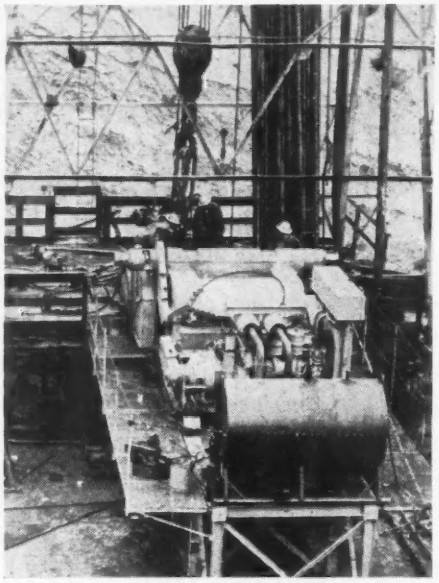
This item supplements Detroit Diesel Engine Division, General Motors Corporation, data on pages 1418-1423 of Composite Catalog, 18th Edition.

Intended for well pulling and workover service on wells ranging to 15,000 feet deep, a new heavy duty well servicing hoist is compact and lightweight. The hoist, which was built by Hopper Machine Works, Inc., is designed for maximum single-line pull of 40,000 pounds. With seven lines the hook capacity is roughly 250,000 pounds.

The hoist is of the double-drum type, with extra sand line capacity, and although it is skid-mounted, it is intended to be used interchangeably on a special semi-trailer with a duplicate unit. The semi-trailer can be equipped with a Hopper "Folding Mast" to permit the servicing of wells without derricks.

A GM "Twin Six" diesel torque converter unit (Model 12107), the prime mover, makes available approximately 300 horsepower at the converter output shaft. Instead of using the conventional jackshaft and selective clutch arrangement, the required high, low and reverse speed ratios are provided by an Allison "Torqmatic" transmission, a hydraulically operated, full-torque shifting planetary transmission.

For additional information, write Detroit Diesel Engine Division, General Motors Corporation, 13400 West Outer Drive, Detroit 28, or Hopper Machine Works, Inc., 38 Herbert Place, Bakersfield, Calif.

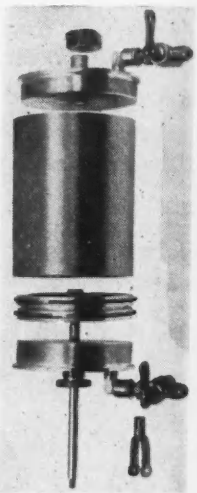


Save Time—Write Direct

As a service to readers, all items in WORLD OIL include the complete mail address of the manufacturer. This makes it possible for those desiring additional information to write any manufacturer without the delay occasioned by going through offices of WORLD OIL, and enables subscribers to request specific data in which they are particularly interested.

Vacuum Control

This item supplements Empire Machinery Company, Ltd., data on page 1613 of Composite Catalog, 18th Edition.



The new Hart vacuum control is a simplified load equalizer for compounded gas or gasoline engines, and is adaptable to oil field installations, marine units, industrial power plants, and other multiple engine drives. A vacuum-differential set up by carburetor suctions vacuum on both sides of a double-acting piston positions a piston rod connected to the throttle valve of each engine. When the vacuum throttle controls have been properly adjusted, the load between two or more compounded engines will be equalized. There are no diaphragms, and the working parts are of metal construction. Each control is interconnected, and the entire system is tied into the carburetor intake manifold of the lead engine. The main parts are a metal piston with two pressure faces and two step-cut sealing rings; a metal cylinder; a brass piston rod; a packing gland and control cocks. The control will equalize the load of as many as four compounded 350 horsepower engines.

For additional information write Empire Machinery Company, Ltd., Odessa, Texas.

Protector Installation

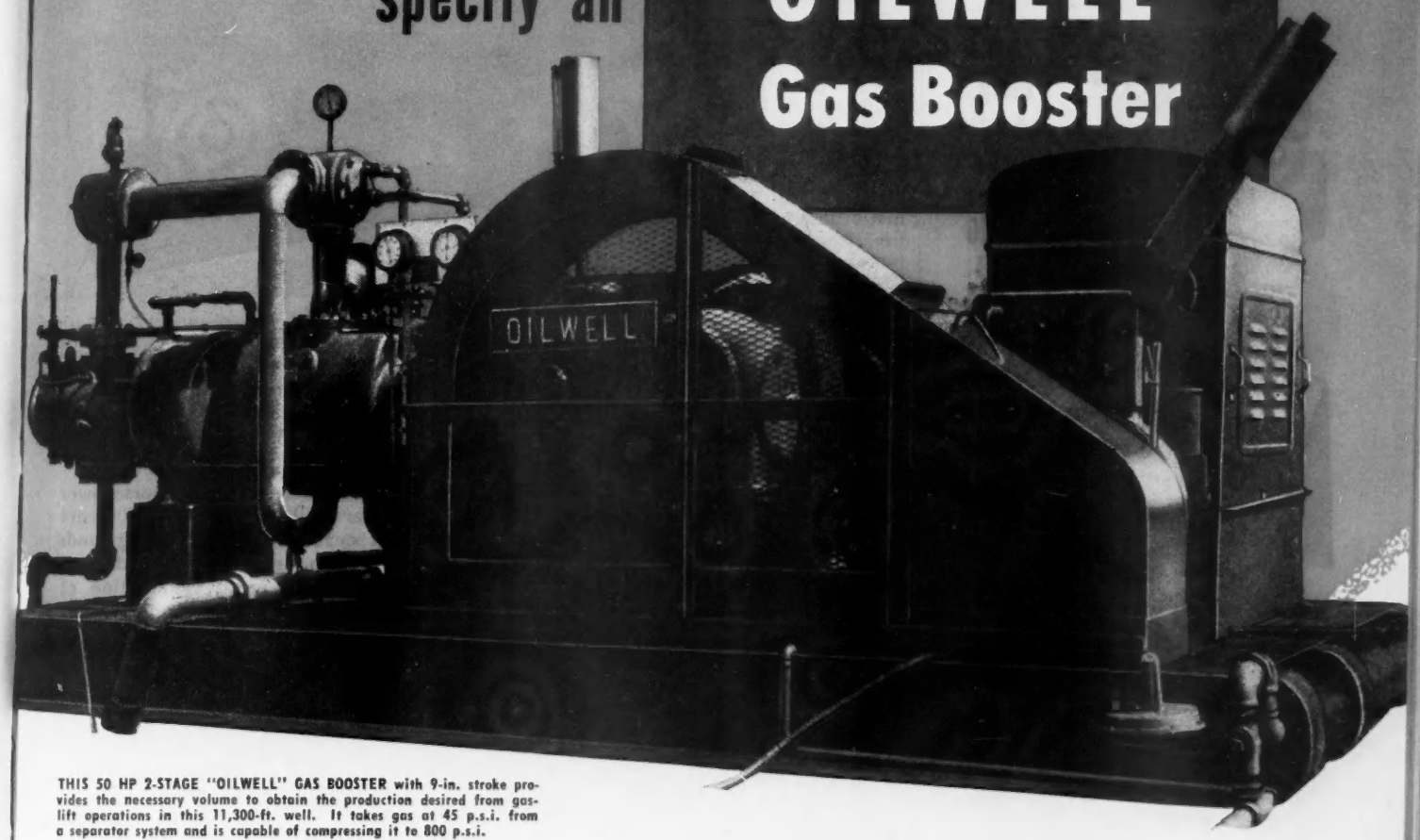
This item supplements Patterson-Ballagh data on pages 4109-4152 of Composite Catalog, 18th Edition.

The new PB expander cone and transfer sleeve are used in installing casing and drill pipe protectors. The highly polished expander cone, "spun" from a steel alloy, provides an expanding surface for the protector as it is transferred hydraulically from its unstretched condition to the transfer sleeve. An installation paste used on all surfaces contacted by the protector insures that the rubber slides freely on the cone and sleeve. The transfer sleeve is the means by which the protector is taken from the hydraulic loading tool to the drill pipe. The sleeve is of sufficient diameter to pass the tool joints, allowing proper placement of protector on drill pipe.

For additional information, write for Installation Bulletin, Patterson-Ballagh, Division of Byron Jackson Company, P. O. Box 2493 Terminal Annex, Los Angeles 54, or 6247 Navigation Boulevard, Houston 11.

For gas-lifting your deep oil the natural way

specify an "OILWELL" Gas Booster



THIS 50 HP 2-STAGE "OILWELL" GAS BOOSTER with 9-in. stroke provides the necessary volume to obtain the production desired from gas-lift operations in this 11,300-ft. well. It takes gas at 45 p.s.i. from a separator system and is capable of compressing it to 800 p.s.i.

"Oilwell" Gas Booster Package-type units are made in sizes from 20 up to 300 HP and with discharge pressures up to 3000 p.s.i. This enables you to select a size and type of unit that is tailored to fit your specific gas-pumping requirements—whether they consist of single-well or group-well gas-lifting operations.

Direct-connected engine-to-compressor type units are now available in the 20 to 50 HP class—utilizing single-cylinder, two-cycle gas engines.

Duplex assemblies are also direct-connected to medium-speed, multi-cylinder engines in the 100 to 300 HP class. V-belt driven units are offered in the 25 to 150 HP class.

Units of all types are designed for continuous operation and exposure to weather conditions. Single or multi-stage compressors are available with units of all types.

Write for complete engineering information... or contact the nearest "Oilwell" store.

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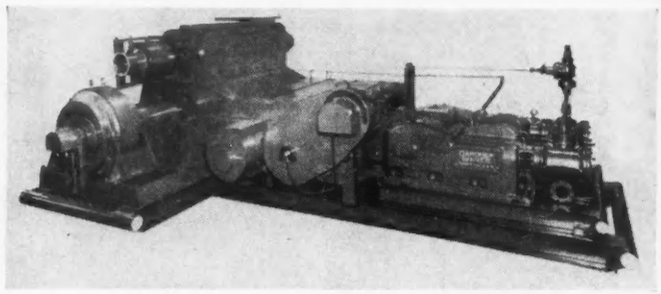
ALTENS FOUNDRY & MACHINE WORKS, INC.
Lancaster, Ohio

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

Steam Drilling Rig

This item supplements Wilson Manufacturing Company data on pages 5113-5160 of Composite Catalog, 18th Edition.



The Titan Steamair is said to be the first drilling rig to utilize steam for motive power with air controlled, air friction clutch, complete with multiple speeds and air controlled catheads. Actually a dual rig, it can be used with either stream engine or internal combustion engines.

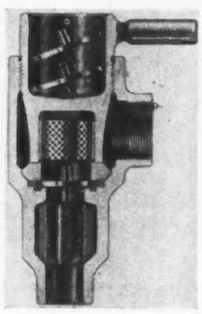
The rig was constructed to allow for the use of steam where an ample supply of water and cheap fuel is available or with combustion engines where water is scarce and conditions necessitate moving the rig at short intervals.

The rig has a reverse lever so that the engine may be reversed if desired, but it is not necessary to use the lever to disengage the clutchs as is common with most steam rigs. In use on the Steamair is the new 46-inch Parkersburg hydromatic brake. It also is equipped with a Wichita dual controlled torque cathead. The rig illustrated is powered by a Gardner-Denver 12 x 12 steam engine.

For additional information write Wilson Manufacturing Company, 707 North Scott Street, Wichita Falls, Texas.

Pressure Release Valve

This item supplements Grant Oil Tool Company data on pages 1953-1976 of Composite Catalog, 18th Edition.



The Grant Safety Automatic Pressure Release valve is available in two models—the two-inch nominal for use on well drilling rigs and pumping units of all types, and the geophysical model for use on mud pumps employed on shot hole and shallow core rigs. The releasing member is a plastic disc that disintegrates as soon as the maximum desired pressure is exceeded, causing an immediate pressure drop. The disintegration takes place inside the valve, so that there is no danger to workmen. New discs can be inserted when required, and it is impossible to put in more than one disc at a time. The nominal valve can be supplied with bushings for any protective pressure up to 5000 pounds. In the geophysical model, the locking screw and bushings are integral parts of the assembly, which is available for pressures up to 1000 pounds.

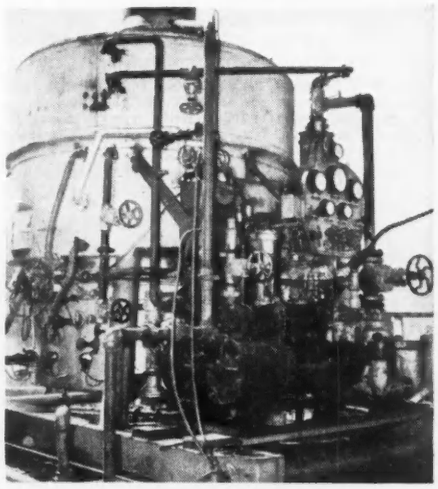
For additional information, write Grant Oil Tool Company, 2042 East Vernon Avenue, Los Angeles.

Oil Burner

This item supplements the Bettis Corporation data on pages 657-666 of Composite Catalog, 18th Edition.

A new oil burner for the 500-horsepower Bettis boiler will evaporate 18,000 net pounds of steam per hour at 500 pounds per square inch pressure with a thermal efficiency of 87 percent. Combustion of the bunker C fuel is at a rate of 180 gallons per hour or a ratio of 12.35 pounds of steam per one pound bunker C.

Construction detail of the burner



(Vapor-Clarkson patent) includes 16 main burners plus four pilot lights, each pilot unit being assigned to four main burners. Minute atomization is possible by the steam injection of fuel through the burner nozzles. The burner is initially fueled with diesel oil and later switched to heated bunker C.

Combustion efficiency is of such a magnitude that plugging of the nozzles or plastering the flues with carbon products is relatively non-existent. The burner control permits automatic operation with full load or minimum capacity demands.

The over-all skid dimension of the oil fired Bettis boiler is 8 feet x 12 feet, 10 inches. With the stack up, the boiler is 22 feet, 2 inches high and the loading height is 10 feet, 8 inches.

For additional information, write Bettis Corporation, 320 South 66th Street, Houston.

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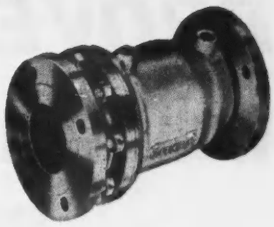
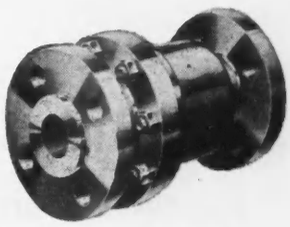


FLEXFLO

Expansible tube type valve for cold fluid services, handles oil, water, solutions, gases and air. Corrosion and erosion resistant. Self-operating by various remote control combinations.

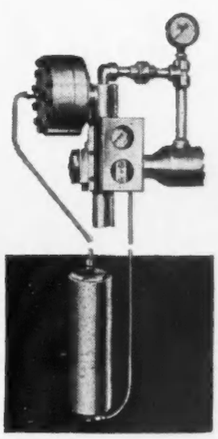


CHEXFLO

Fully self-contained, self-operating check valve, closes on balanced flow prior to the start of return flow. Ideal for handling corrosive fluids or gases. Bubble-tight shut-off, no metallic moving parts.

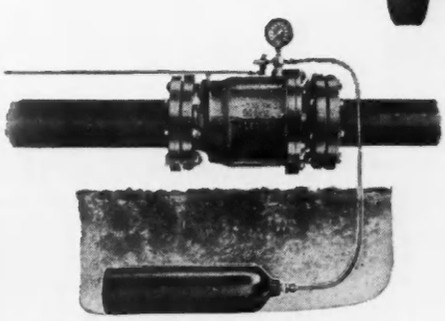
SERIES "S" FULLSTREAM CHECK VALVE

For high pressure services on compressor discharge or flow lines. Streamlined design gives minimum pressure drop. The valve piston closes with a cushioning effect, so there is no clattering or pounding action to cause wear and shorten life.



MODEL PB-300 REGULATOR

For severe services, as a back pressure or pressure reducing regulator, stands up to toughest conditions. Working parts protected from gas blast, resists freezing or sand cutting. Handles pressures up to 6000 lbs. reducing, 3000 lbs. back pressure service.



MODEL 888 PRESSURE LOADED RELIEVER

Instant response to slightest variation in line pressure, opens and closes smoothly with no sticking, chattering, leakage or failure. Equally suitable as Back Pressure Regulator opening on constant or intermittent flow.

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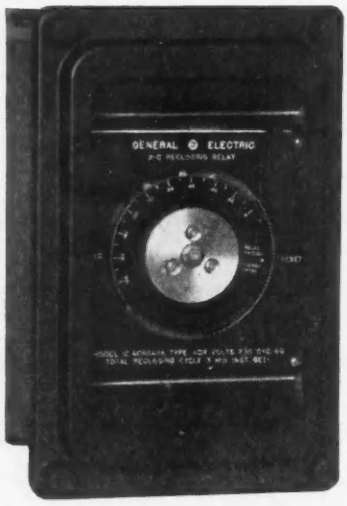
NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

Reclosing Relay

This item supplements General Electric Company data on pages 1809-1820 of Composite Catalog, 18th Edition.



A new reclosing relay, type ACR, is specifically designed for use on automatic reclosing equipments with all types of power circuit breakers.

The new relay has optional automatic reset at a definite time after any successful reclosure attempt; a self-contained means for permitting instantaneous initial and time-delay subsequent breaker tripping; and fast immediate reclosure.

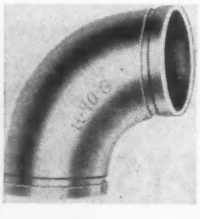
The ACR relay may be adjusted for one, two or three delayed reclosures in addition to the immediate reclosure. The delayed reclosures occur at 15-second minimum intervals. By adjustment of the cams, longer intervals can be obtained; or the definite time reset after immediate reclosure attempts can be omitted, in which case delayed-reclosure intervals as short as five seconds can be obtained. The connections of the relay can be changed to omit the immediate initial reclosure.

For additional information write for Bulletin GEA-5593, General Electric Company, Schenectady 5, N.Y.

Grooved Pipe Fittings

This item supplements Gustin-Bacon Manufacturing Company data on pages 2102-2103 of Composite Catalog, 18th Edition.

Gruvagrip malleable fittings are now available in a complete line for grooved pipe, and include L's, T's, adapter nipples, crosses, laterals, bull plugs and reducers. the new fittings are in sizes ¾-inch to 12 inches, and withstand the same working pressures as Gruvagrip grooved pipe couplings. Inside walls of Gruvagrip fittings are true circles, smooth and gently curved to prevent turbulence and frictional losses. The fittings can be removed from the line without disturbing the rest of the piping system. They readily take paint, and come painted with a prime coat that contains two types of rust inhibitors.



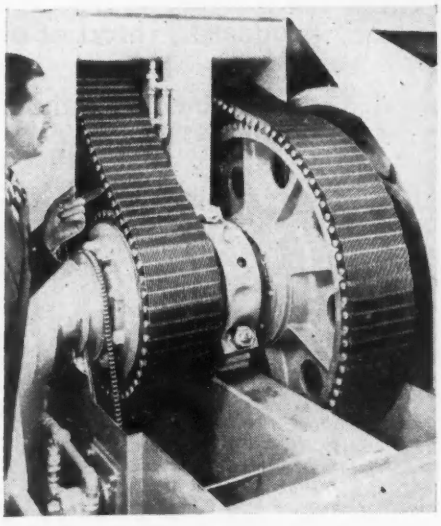
For additional information write Gustin-Bacon Manufacturing Company, 1416 West 12th Street, Kansas City, Mo.

Chain Drive

This item supplements Morse Chain Company data on pages 3486-3491 of Composite Catalog, 18th Edition.

The new Morse Hy-Vo (high velocity) chain drive is a power transmitting medium that combines the ruggedness and dependability of a gear drive with the smoothness and lack of vibration of a belt. A new chain-and-sprocket engagement principle virtually eliminates "chordal" or polygon action common to the usual chain drive. Hy-Vo sprockets resemble involute gears having curved involute teeth which engaged the Hy-Vo links with conjugate action.

The chain has a new, compensating rocking join designed to eliminate slippage and wear. During chain articulation, the joint shifts the pitch-line automatically,



engaging the involute sprocket teeth in such a way that the chain follows a path truly tangent to the sprocket pitch line. This results in a smooth, almost vibrationless action.

Pitch elongation or "stretch" has been minimized in the drive to the extent that it is virtually unnecessary to provide any means of take-up. The drive is thus suitable for use on drive applications such as engine compounding or heavy-duty power transfers where center adjustment is impractical.

Hy-Vo drives are available in 1-, 1½- and 2-inch pitches, in standard chain widths.

For additional information write Morse Chain Company, 7601 Central Avenue, Detroit 8, Mich.

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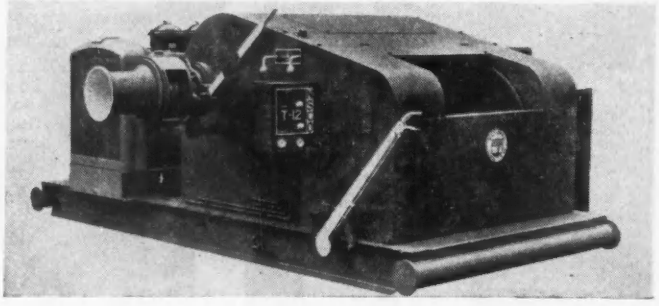
NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

Shallow Drilling Rig

This item supplements The National Supply Company data on pages 3433-3564 of Composite Catalog, 18th Edition.

For shallow drilling, medium depth servicing and workover jobs, the Ideal Type T-12 drilling rig, designed for 120 input horsepower, will normally be considered for drilling in the 1500 to 3000 feet depth range and for servicing and workover jobs in the 3000 to 6000 feet range. The T-12 rig is adaptable to trailer or truck mounting.



The engine-mounted hydraulic torque converter drive is augmented by two drawworks speed ratios to the drum and rotary table. This high and low speed selection, combined with torque converter characteristics, provides an efficient utilization of available engine power for all drilling requirements. Fluid power transmission permits the fastest possible round-trip time with a given size of engine, eliminates "lugging down" and stalling the engine, and minimizes shock loads, according to the manufacturer.

Air controls are provided for Fawick Airflex clutches on the main drum, sand reel drum and rotary drive, and for the engine throttle, inertia brake and breakout cathead. The hoisting drum, 12¾ inches in diameter and 36 inches long, is a free spooling type mounted on roller bearings. A new wire line clamp locks the end of the line into a socket on the side of the drum flange, thus making removal of guards unnecessary. National's compound equalizing brakes are used on the drum.

For additional information, write The National Supply Company, Box 889A, Toledo, Ohio.

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Model 2144-S

Model 2146-S
Has second bulb which is automatically flashing red light. $9.80 less batteries. Both models are approved by Underwriters Lab., Inc. for Class 1, Group D hazardous locations, U. S. Bureau of Mines, and U. S. Coast Guard Merchant Marine Tech. Div.

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This progressive manufacturing and service policy gives you the advantage of having Rectorheads, Rector "Fulbore" Cementing Equipment, Rectorseal and other Rector Products available from 35 supply companies operating throughout the United States and Canada.

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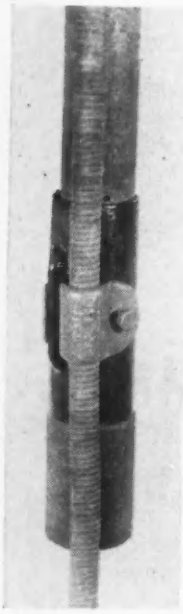
RECTORHEAD RECTOR FULBORE CEMENTING METHOD RECTORSEAL

OTHER NEW AND IMPROVED EQUIPMENT

Swivel Clamp



The Rosen Swivel Type Safety Clamp secures the cable onto the tubing at intervals of 150 to 180 feet, or may be spaced closer if conditions warrant. The nine-foot cylinder part has outside diameter no larger than the collars of the tubing on which it is used. The cylinder sleeves over the upset end of the tubing and rests freely on the collar after the joint is made up. The cylinder is free to rotate on its supporting bearing, the collar. Once this part is installed it is not removed when pulling the tubing but may be allowed to remain in the middle of the stand, or it may be left on the joint at the break when the stand rests on the floor. The other part of the clamp is a hook three inches wide made of cast steel with corrugations inside to correspond to those of the armored cable. After the joint is made up the hook member is inserted and hinged over the cable. In one operation the cable is secured onto the cylinder which is free to assume any position about its base, thus bypassing any solid object as the tubing is run in the hole.

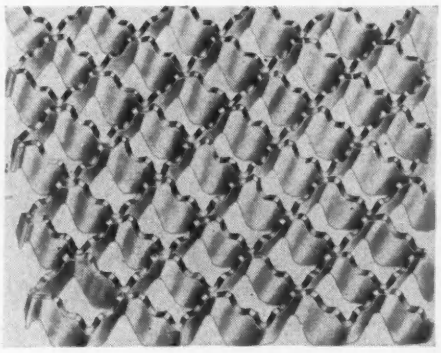
For additional information write Leo Rosen, Box 4577, Oklahoma City.

Dual Recording System

A new technique records simultaneously both the radioactivity and rock strata resistance in underground drilling operations and other industrial and scientific applications. The system consists of a two-pen electronic recording instrument for obtaining data in a single operation. The same device may be used for spectrometer analyses. The simultaneous recordings require only one recording "pass," permitting speedy withdrawal of an entire electrode from a well.

For additional information write Minneapolis-Honeywell Regulator Company, Brown Instrument Division, 4494 Wayne Avenue, Philadelphia 44.

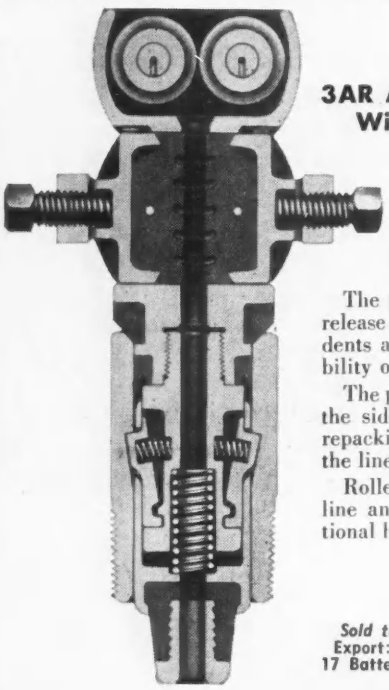
Non-Skid Grating



A new safety grating with a non-skid design is made of notched metal strips one-eighth inch thick. It is adaptable as a safety measure in all industrial uses where excessive oil, grease, water and icy conditions make walking and working hazardous. "Firm-Grip" grating can be used on platforms, stair treads, ramps, catwalks, steps for trucks, engine rooms, etc.

For additional information, write Bustin Iron Works, Inc., 110 East 130th Street, New York 35.

FOR SWABBING— Be Sure IT'S A KING Be Safe —FOR CORING



3AR Automatic Release Wire Line Stripper

Type 3AR King Wire Line Stripper is the ideal tool for use in swabbing operations.

The positive latch and sure release insure against accidents and eliminate the possibility of breaking a line.

The packing is inserted from the sides of the stripper and repacking is easily done while the line is in the hole.

Roller line guides center the line and outwear the conventional bushing.

4AR King Type Stripper For Wire Line Coring

Type 4AR Wire Line Stripper is similar to the 3AR, except it is a little larger. Although it can be used for swabbing, its primary use is for wire line coring operations. The 4AR is commonly used with King circulating heads. When required, both the 3AR and 4AR can be furnished with 1½" pipe thread on the bottom for attachment to a trip bar.

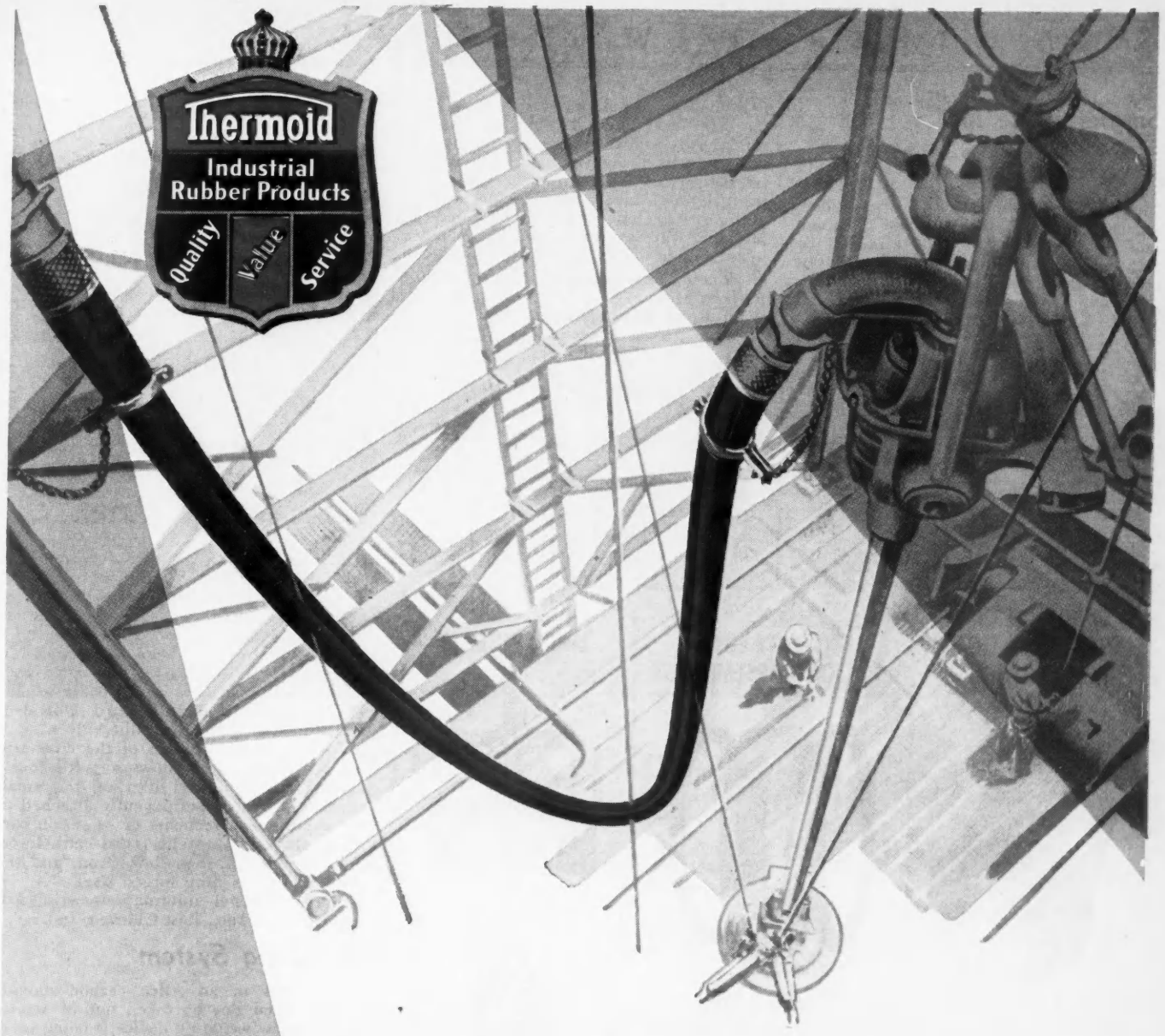
Sold through your supply store
Export: R. S. Stokvis & Sons, Inc.
17 Battery Place, New York, N. Y.

See your latest Composite Catalogue for detailed descriptions of other King Tools.

KING OIL TOOLS

210 Terminal Street **Phone OS 3-3421**

HOUSTON 20, TEXAS



Powerflex Rotary Hose Is Pre-tested Under Tougher Than Field Conditions

Thermoid Powerflex Rotary Hose is tested to 5000 psi before shipment. And that's a far greater pressure than it will ever meet in the oil fields.

But Thermoid Powerflex can take it. Because, like all Thermoid products, it is made with an extra margin of safety and endurance.

The tube is oil-and-abrasive resistant synthetic rubber, reinforced with steel cables and pre-stretched fabric. Cover resists aging, abrasion, cracking. Couplings are built in, and anchored securely for the life of the hose.

Throughout the oil fields everywhere, Thermoid has come to mean safety, dependability, long-wearing economy—whether it's Powerflex Rotary Hose, "No-Wip" Line Savers, wire line turnbacks or any other Thermoid quality product.

Mid-Continent Office and Warehouse: Houston, Texas

SEE OUR CATALOG IN THE COMPOSITE CATALOG

Thermoid

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah

Single Phase Motor

Single phase capacitor type motors has been added to the Sterling line of "Klosd" drip-proof motors.

"Klosd" motors may be sidewall mounted, inverted ceiling mounted or floor mounted, and still retain the drip-proof quality by rotating the end bells so that the air vent openings point downward.

In addition to retaining the features of the 2- and 3-phase "Klosd" motors, the new single phase motors have a new starting relay that eliminates the necessity of centrifugal switches or any rotating devices such as throw out switches, commutators, brushes, etc. Sterling one-piece case iron stator frame, "Herringbone" rotor, prelubricated ball bearings, Vinol-acetal-insulated wire stator windings are included in the design of the single phase motors.

For additional information, write Sterling Electric Motors, Inc., 5401 Anaheim-Telegraph Road, Los Angeles 22.

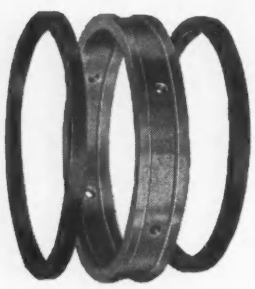
RED DEVIL

"DIA-HARD" LINERS

For high pressure abrasive service

Forged in one piece from highest quality alloy steel. The deep HIGH-CARBON wear resistant case of maximum hardness and uniformity is obtainable only by our SPECIAL "DIA-HARD" PROCESS, greatly excelling all other known methods for longer life liners. The bore is PRECISION HONED, and ACCURATE OUTSIDE DIMENSIONS insure a perfect working fit with liner packing assembly and pump cylinder for positive leakproof sealing. Write for Catalog No. P-120.

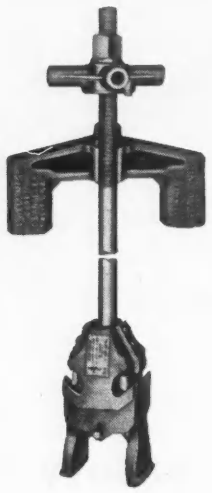
TELL-TALE LINER PACKING ASSEMBLIES



Gives warning before damage

Tell-Tale Liner Packing Assembly consists of two "DIA-TEX" oil and heat resistant sealing rings separated by a precision made steel, corrosion-resistant lantern ring. Internal leakage is detected instantly in slush pumps through "tell-tale holes" before costly fluid cuts occur to cylinder walls. There is either a Tell-Tale Liner Packing Assembly or a "DIA-TEX" Sealing Ring available for all makes of slush pumps. Write for Catalog No. P-121.

LINER PULLERS



Save valuable time and labor

The Red Devil Liner Puller is a strong, heavy duty, dependable tool capable of pulling the most obstinate liner. Its operation is simple. There are no pins, connecting links or other small parts to bend, shear, break or become lost.

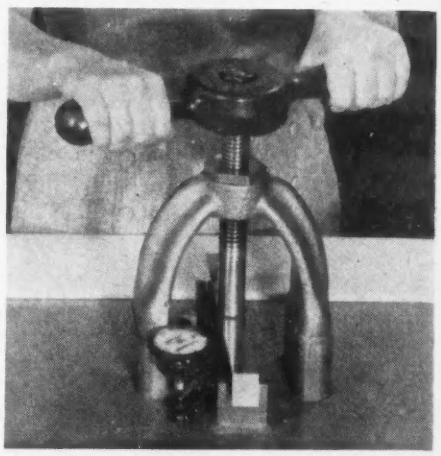
The "Universal Type" Puller (as illustrated) is designed for slush pumps. The "Expanding Grip Type" is designed for pulling thin wall-driven tube type liners, as used in small pumps. Write for Catalog No. P-122.

See Composite Catalog . . . For more detailed information on Red Devil Products, see the Composite Catalog or write for special price catalogs noted above. Red Devil products are available through your supply store.

OIL WELL MANUFACTURING CORP.

6008 S. Alameda St., Los Angeles 1, Calif.

Cross-Arm Handle



A new cross-arm handle incorporating the Edward Impactor handwheel principle is a means for exerting greater effort to positively close a valve against high operating or test pressures, and delivers 2.8 times the closing force of regular handwheels. The handle is applicable to many small Edward valves, and is especially suited for 1¼, 1½, and 2-inch Edward Univalves and 2-inch Edward hydraulic valves.

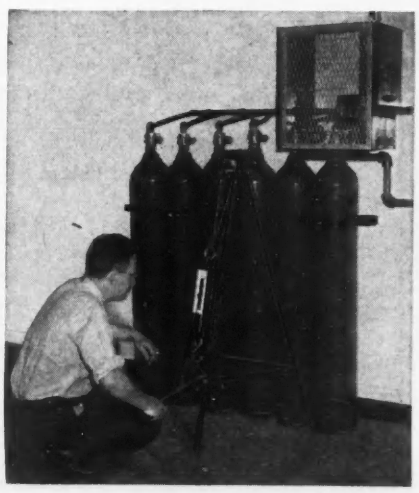
In operation, two lugs of the cross-arm handle strike equal blows simultaneously against the opposite sides of the small adaptor, which is permanently attached to the valve stem. Wrenches or extension bars are not needed to deliver this extra force. The handle is cast mallable iron, and the stem adaptor is drop forged steel.

For additional information, write Edward Valves, Inc., East Chicago, Ind.

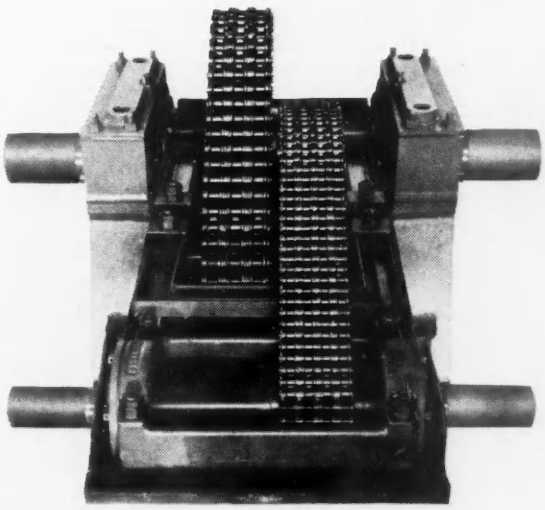
Weighing System

Cylinders in an Alfco carbon dioxide battery need not be taken out of service when a new weighing device is being used. The operator simply loosens the clamp bolts which hold the cylinder in place, inserts the fulcrum under the neck of the valve, and presses down the hand lever until the cylinder clears the floor. The reading on the scale shows the weight. The 28-pound device is made of channel iron and has a capacity for weighing up to 200 pounds.

For additional information, write American - LaFrance - Foamite Corporation, Elmira, N. Y.



For Tough Oil Well Pumping Service
DIAMOND CHAIN RUGGEDNESS Adds Dependability



Speed Reducer for pumping,
—multiple Diamond Roller Chain.

Typical scratch-gauge record, "controlled starting" test.

● In tough continuous pumping service, Diamond Roller Chain driven rigs provide dependable year 'round performance.

Uniformly strong Diamond Chains well withstand the variations in loading while their inherent elasticity helps reduce the intensity of shock loading on other parts of the installation. Diamond drives create no end thrusts or separating forces.

Long records made on wells all over the world—have proved the reliability and economy of Diamond Roller Chains.

DIAMOND CHAIN COMPANY, Inc., Dept. 485, 402 Kentucky Avenue, Indianapolis 7, Ind. *Tulsa Office:* 2238 Terwilleger Blvd.

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PRODUCTION ENGINEERING
SERVICE, INCLUDING
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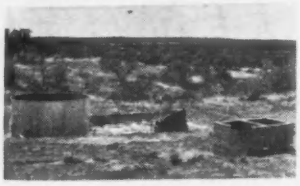
PRESSURE MAINTENANCE WITH GAS OR WATER

"OPEN"
SALT WATER
DISPOSAL SYSTEM



Shackelford
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REPRESSURING WITH GAS OR WATER

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ESTIMATES
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SUPERVISION

PETROLEUM ENGINEERS
CABLE & STINE
WICHITA FALLS, TEXAS

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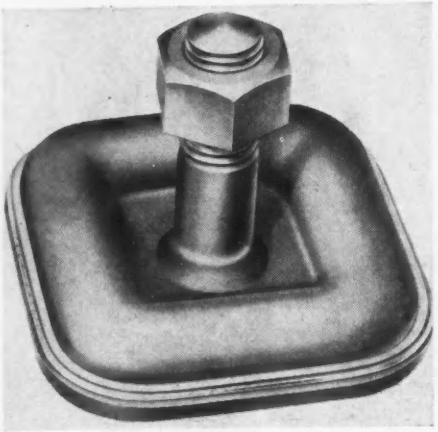
OTHER NEW EQUIPMENT

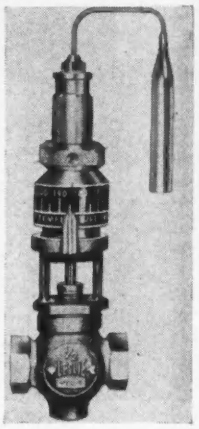
Gaskets



Flexitallic Style T gaskets for maintaining seals for boiler handhole and tubecap cover assemblies require no compounds and can frequently be reused if not removed from cover assemblies during outage. The Flexitallic Spiral-Wound construction consists of spiral winding of V-crimped plies alternated with plies of filler. Resiliency of the V-crimp permits the gaskets to rebound when they are not under compression. Thicknesses available are .125 inch for use with assemblies having narrow seating surfaces and high bonding loads, and .175 inch for use in assemblies having broad seating surfaces and low bonding loads. Operating ranges are 0-499 pounds; 0-999 pounds; and 1000 pounds and above. The gaskets are made of low carbon plated steel and Canadian asbestos filler, and Type 304 stainless steel and Canadian asbestos filler.

For additional information, write Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 5, N. J.

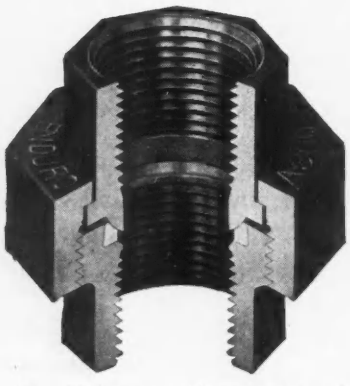
Calibrated Dial



A new calibrated dial for use with Leslie Class T and Class M temperature regulators requires only a quick turning of the dial to the desired setting for operation. There is no need to wait for the equipment to heat up to find out if the setting is correct. The new calibrated dial is also said to provide protection against overheating caused by guess setting. The dial fits in place of standard adjusting sleeve. There are no complicated linkages or gauges to add friction.

For additional information, write Leslie Company, 359 Delafield Avenue, Lyndhurst, N. J.

Jefferson Malleable Unions



JEFFERSON'S *ENDURO* unions available in brass-to-iron, and iron-to-iron seats. Certified Air Furnace iron used in the ENDURO line is A.S.T.M.-4733-Grade 35018 malleable, having a 53000# Min. Ten.

ENDURO—300# S.W.P.—600# C.W.P.

Certified Air Furnace iron produces a constant, uniform, finer grain structure union. This provides a much better iron with which to provide a positive dependable seating surface.

Unions manufactured from this malleable iron afford 30% more strength; 50% more impact value; 75% more elongation. Sizes ¼" thru 3".

Obtainable through your jobber

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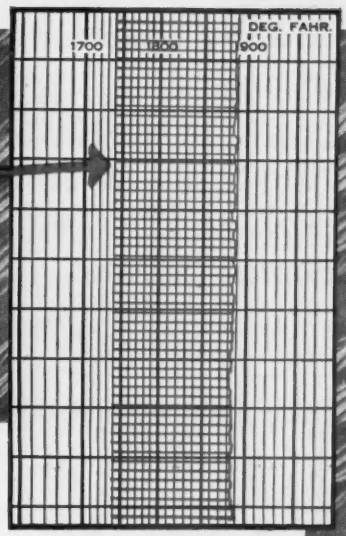
71 Gooding St., Lockport, New York
31 Fletcher Ave., Lexington 73, Mass.

ALL ROPES *look* ALIKE... but

IN *Wickwire Rope*

GRAIN SIZE OF STEEL IS ALWAYS UNIFORM



What has grain size of steel to do with longer rope life?

Plenty!

That's because in every commercial grade of wire rope, there's a certain critical grain size that gives highest resistance to bending fatigue. In Wickwire Rope we make sure that you get this definite grain size and that it is always uniform to exacting McQuaid-Ehn* standards.

Only a fully integrated company like Wickwire can give you this big advantage... because such control of grain size is possible only where all phases of manufacture are under constant check and test... starting with the melting and refining of the steel and continuing through heat-treating processes and cold drawing of the wire.

Here again—Wickwire goes "beyond specifications" to give you assurance of wire rope that can't be beat for reliability, safety and longer life.

***For detailed information on the McQuaid-Ehn test, write to our Sales Office, at Palmer, Mass.**

LOOK FOR THE YELLOW TRIANGLE ON THE REEL

Automatic heat control in our patenting or heat treating furnace operates within such close limits that the temperature in the furnace never varies more than a small fraction of one per cent.

WICKWIRE ROPE

A PRODUCT OF THE WICKWIRE SPENCER STEEL DIVISION OF THE COLORADO FUEL AND IRON CORPORATION

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PACIFIC COAST SUBSIDIARY—The California Wire Cloth Corporation, Oakland 6, California

Oil Industry Equipment

A new two-color catalog covers the complete line of Pelton oil industry machinery equipment, including the Long Stroke Hydraulic Pumping Jack, the beam unit, and accessories.

For a copy of this catalog, write Pelton Water Wheel Company, 2447 East 54th Street, Los Angeles 58.

Acidization Services

A report on services offered and a brief history of the company are included in a new 12-page multicolored booklet. Acidization of wells through use of the "Permeter" is discussed.

For a copy of this booklet, write Chemical Process Company, Division of Independent-Eastern Torpedo Company, Breckenridge, Texas.

Needle Valves

The Kerotest line of forged steel, union bonnet needle valves for high pressures and corrosive services is described in a new folder. Price list is included.

For a copy of this folder, write Kerotest Manufacturing Company, 2525 Liberty Avenue, Pittsburgh 22.

Roller Chains

A new catalog covering a full line of roller chains and sprockets from stock provides complete specifications and engineering reference tables. Dimensional data, strengths and weights are also supplied on allied products, such as block chain, cable chain and flexible couplings.

For a copy of Catalog RS-50, write Whitney Chain Company, 237 Whitney Street, Hartford, Conn.

Multi-Stage Compressors

Engineering data to allow an engineer to approximate the power requirements, rotative speed and discharge temperature for most multi-stage centrifugal compressor applications is included in a new catalog.

For a copy of this catalog, write Clark Bros. Company, Inc., Olean, N. Y.

Rotary Drilling Head

Installation, operating and maintenance of the Guiberson Type "J" rotary drilling head are detailed in a new manual. Procedures for changing rubbers and wash pipe and lubrication requirements are discussed. An exploded parts illustration, engineering data and parts price list are included.

For a copy of this bulletin, write The Guiberson Corporation, 1000 Forest, Dallas.

Two-Cylinder Diesel

Construction and operations features of the Nordberg four-cycle, one cylinder and recently introduced two-cylinder, vertical, mechanical injection, Type 4FS diesel engine are described in a new two-color bulletin.

For a copy of this bulletin, write Nordberg Manufacturing Company, Milwaukee 7, Wis.

Sucker Rods

A four-color, 40-page, spiral-bound bulletin on sucker rods and couplings traces every step in the manufacture and processing, goes into detail regarding the metallurgy of each type of rod and the use for which it is best suited; tells how to get longer life from D+B rod strings, and describes D+B engineering and field services.

For a copy of this bulletin, write D+B Division, Emsco Derrick and Equipment Company, Garland, Texas.

Valves and Specialties

Worthite valves, flanges, hose nipples, bars, welding electrodes and screw machine products are described in a new two-color folder. Applications of each product are discussed, and engineering drawings and specifications are given.

For a copy of Bulletin W-350-B5C, write Worthington Pump and Machinery Corporation, Harrison, N. J.

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No need to tie-up operating capital in drilling equipment! Just call "Associated"! Drill pipe and tools are maintained in excellent condition. ready for immediate delivery on rental basis. All six yards (listed below) are equipped to give you fast 24-hour service!

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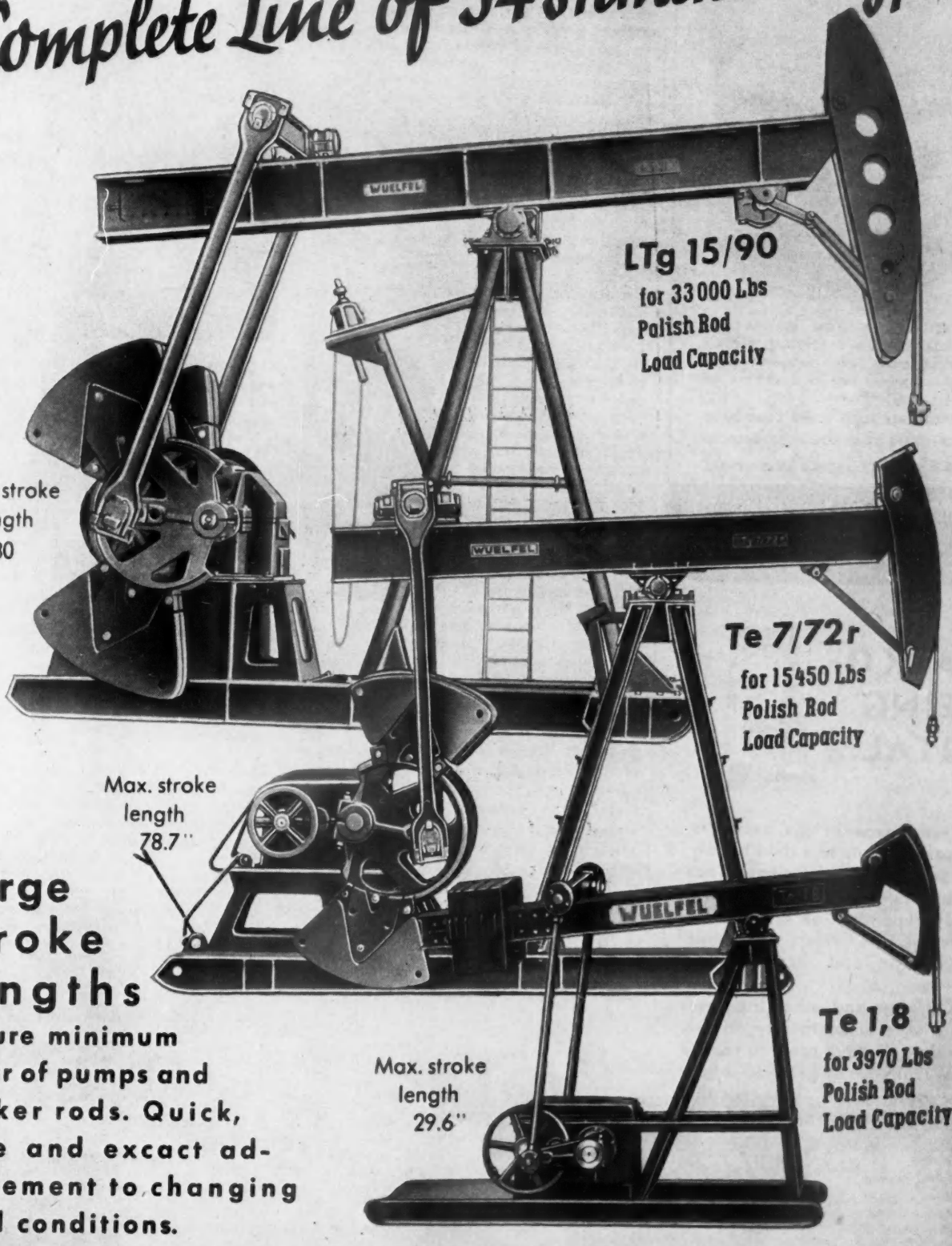

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for 33000 Lbs
Polish Rod
Load Capacity

Max. stroke
length
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Large stroke lengths
ensure minimum wear of pumps and sucker rods. Quick, safe and excact adjustement to changing well conditions.

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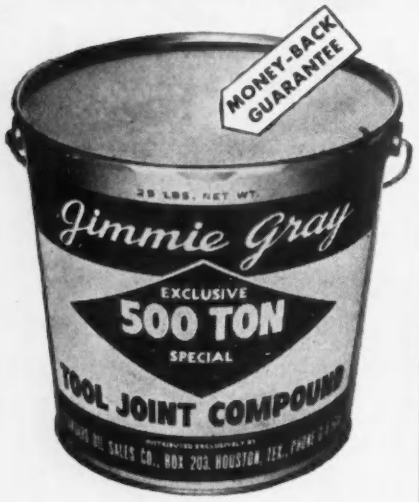
L-O-N-G-E-R
THREAD LIFE



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Oil men and other businessmen have come to rely on this service . . have come to realize that Trans-Texas *gets you where you want to go* – economically, speedily, comfortably.

For information call Trans-Texas Airways or your travel agent.

TRANS-TEXAS Airways

Men in the Industry NEWS

K. S. Adams, president of Phillips Petroleum Company since 1938, has been elected chairman of the board and chief executive officer and chairman of the executive committee. **Paul Endacott** was elected president. Endacott, as executive vice president and assistant to the president, has been the operating manager of the company and will continue in the same capacity as president.

Stanley Learned was elected executive vice president and assistant to the president. **W. W. Keeler**, formerly vice president of refining, was elected a director, and vice president and assistant to the executive vice president. **J. E. Bogk** was appointed chairman of the operating committee.

•

Dr. Richard J. Gonzalez has been elected a director and **Rex G. Baker, H. W. Ferguson** and **Morgan J. Davis** have been elected vice presidents of Humble Oil & Refining Company.

R. J. Gonzalez

Dr. Gonzalez, the new director, took his Ph.D. in economics from the University of Texas in 1934 and after a brief teaching career at the University of Texas and University of New Mexico, joined Humble in 1937 as its economic advisor. He is now in charge of economics and statistics for the company. He has been active in the work of industry committees, being chairman of the Economics Advisory Committee of the Interstate Oil Compact Commission from 1946 through 1949, member of the API Special Advisory Committee, and of the Panel on Economic and Political Factors of the National Petroleum Council's Subcommittee on Long Term Domestic Oil and Gas Availability. In addition, he has served as a member of the Petroleum Advisory Committee to the Texas Legislative Council.

The three new vice presidents are all long service employes of the company. Baker took his B.A. and LL.B. degrees from the University of Texas in 1917 and joined the Humble's Law department in June, 1920. He was elected a director and made general counsel in 1943.

K. S. Adams, right, new chairman of the board and chief executive officer and chairman of the executive committee of Phillips Petroleum Company, is pictured with Paul Endacott, who succeeded him as president of the company.

Davis, after taking a degree in geology from the University of Texas in 1925, joined Humble in that year as a geologist in West Central Texas. After four years with Humble, Davis joined Nederlandsche Koloniale Petroleum Mij., with headquarters in Java, returning to Humble in 1934. After a series of promotions, Davis in 1946 became manager of exploration and in 1948 was made director responsible for exploration.

Ferguson, who joined the company in 1924, is director in charge of refining and sales operations.

•

Maj. Gen. Harry H. Johnson, formerly with Gulf Oil Corporation in Houston has assumed the presidency of Algonquin Gas Transmission Corporation, and will make his headquarters in Boston. Johnson has also been named a director of Algonquin.

Johnson has been in the petroleum industry 31 years. His military career dates back to his original enlistment in 1917. He was the first military governor of Rome in 1944, and was a major general at the close of World War II.

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PELICAN WELL TOOL & SUPPLY CO.

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Lufkin PERFECTION

. . . . IN CRANK COUNTERBALANCING

The Lufkin Trout Crank gives perfect counterbalance adjustment from minimum to maximum effect with the greatest of ease. One man can easily do the job. Two methods are illustrated herewith. Any method of moving the weights is safe because the weights are equipped with steel safety lugs to prevent sliding off the crank.

Operators find the Lufkin Trout Crank superior for oil field pumping units because of these outstanding features:

1. **EASE OF ADJUSTMENT**—one man can counterbalance a well.
2. **SAFETY**—a steel safety lug prevents the weights sliding off the crank.
3. **PRECISION** — counterbalance of minimum to maximum effect can be obtained by moving weights in a straight line.
4. **SIMPLICITY**—only three bolts to loosen.

"LET THE WEIGHTS DO THE WORK." Illustrated above is a very acceptable method of shifting weights on a Lufkin Pumping Unit. The crank is stopped on an incline, the three bolts are loosened and the lead bolt is used as a brake. This operation is quite safe because the weights are equipped with a steel safety lug to prevent sliding off the crank.

Another acceptable method of counterbalancing a Lufkin Unit is to stop the crank on a slight incline, prying the weight along the machined ways of the crank with the aid of a bar. This method is made easy by the notched bottom of the crank slot, enabling the operator to reach the desired position by an easy sliding motion.

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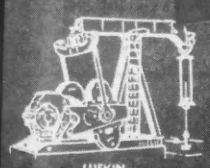
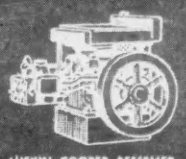


LUFKIN PUMPING UNITS



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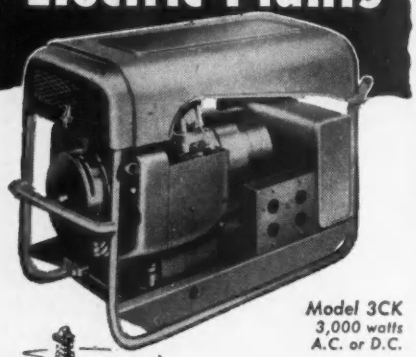

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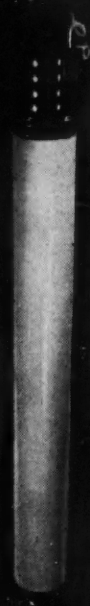

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MEN IN THE INDUSTRY NEWS

Robert L. Kidd

John H. Purnell

Reese H. Tucker

Robert L. Kidd, vice president and manager of the Land and Geological division of Cities Service Oil Company, Bartlesville, Okla., has been appointed assistant to the president, **A. W. Ambrose.** He will continue to work on oil exploration and development. **Reese H. Tucker**, chief geologist, succeeds Kidd as manager of the Land-Geological division.

John H. Purnell, formerly editor of the Bartlesville *Examiner-Enterprise*, has been named director of publications and news for the company.

James W. McColl, Bartlesville, has been appointed assistant superintendent of the Land department.

Kidd, who is also a director, has been with Cities Service more than 25 years. He served as development geologist at Madison, Kansas, resident geologist at Oil Hill, Kansas, chief geophysicist, assistant chief geologist and chief geologist at Bartlesville. In 1945 he was promoted to manager of the Land and Geological division and three years later was elected a vice president.

Tucker was first employed by Cities Service in 1930 as a junior engineer, with permanent assignment in the Geological division. In 1948 he was appointed manager of the Geoghysical department. The following year, he was named chief geologist for the company.

Purnell was editor of newspapers at Paris and Marshall, Texas, before he went to Bartlesville. He was also public relations director of the East Texas Chamber of Commerce.

McColl was first employed by the company in 1939 as landman in the Illinois area, transferring later to the Bartlesville office. After service in the Pacific Theater as a major in the Army, he rejoined the company as a member of its legal staff. His transfer back to the Land department came last year. McColl was graduated from the University of Oklahoma Law School in 1938.

●

Paul B. Leavenworth, formerly chief geologist for the Houston district of Gulf Oil Corporation, has joined Housh Drilling Company as manager of exploration, and will have offices at 586 Gulf Building Addition, Houston. Leavenworth had completed 35 years of service with Gulf.

BIG FOUR MACHINE AND SUPPLY COMPANY 4

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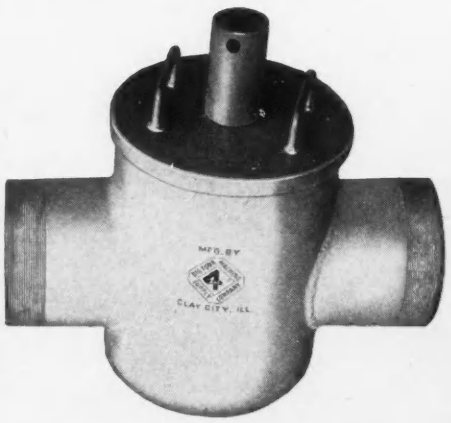

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G. T. Pearson, assistant regional manager of production in Continental Oil Company's Central region, with headquarters in Oklahoma City, has been promoted to regional manager of production. He succeeds **L. P. Carpenter,** retired. **E. C. Wilbur,** superintendent of the company's Oklahoma-Kansas division, Ponca City, Okla., was promoted to assistant regional manager of production, Oklahoma City, succeeding Pearson.

C. R. Wallen, superintendent of the Illinois Basin district, Griffin, Ind., was promoted to acting division superintendent, Ponca City; and **R. F. Darrow,** district foreman, Hobbs, N.M., was promoted to district superintendent, Griffin.

G. T. Pearson

E. C. Wilbur

Pearson joined Continental in 1930 as a roustabout in the company's Seal Beach, Calif., field and rose through successive promotions to general production superintendent at Los Angeles in 1947. He moved to Fort Worth in 1949 as assistant regional production manager, and in 1950 was transferred to Oklahoma City as assistant regional production manager. Pearson is a graduate of the University of Southern California.

Joining Continental at Ponca City in 1919 as a district superintendent of production, Wilbur has remained at Ponca City through various promotions. He was promoted to superintendent of the Oklahoma-Kansas division in 1943.

Wallen went to work for Continental at Fort Collins, Colo., in 1927. He later served as farm boss and then district foreman in the Illinois Basin and moved to Edmond, Okla., in 1947 as assistant district superintendent, returning to the Illinois Basin in 1950 as district superintendent.

Darrow, who joined Continental in 1933 in California, moved up through promotions to district foreman at Ventura, Calif., in 1949, and was promoted to district foreman, Hobbs, N. M., in 1950.

•

John E. Eckel has joined The Carter Oil company as a research engineer with headquarters in Tulsa. For the past two years, Eckel has been president of The Petroleum Mechanical Engineering Development Company in Houston.

John E. Eckel

A graduate in petroleum engineering of the University of Oklahoma in 1929, Eckel joined Humble Oil & Refining Company and worked as a junior engineer in Houston until 1932, then as district engineer at Conroe, Texas, until 1935. In 1936 he returned to Houston as senior engineer in equipment investigations until 1944, when he was transferred to Humble's Gulf Coast division. He joined Oil Center Tool Company in 1945, and at the time of his resignation to organize his own firm, was vice president in charge of engineering for O-C-T.

•

Dechard A. Hulcy, president of Lone Star Gas Company, Dallas, has been elected president of the Chamber of Commerce of the United States. Hulcy, who is also president of the American Gas Association, joined Lone Star in 1920. In three years he was advanced to chief clerk in his section of the accounting department, and by 1927 he was assistant comptroller. In 1929 he was named to the new post of assistant to the president, and by 1935 he was a vice president and member of the board of directors. The next year the office of executive vice president was created for him. He became president in 1940.

D. A. Hulcy

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Richard K. Huey, who has been vice president in charge of Deep Rock Oil Corporation's production division, has been named assistant to the president, and is succeeded by **Carl A. Houy**, who has been general superintendent since March, 1950. In his new capacity, Huey will work on special assignments involving producing properties.

Huey started in the utilities business nearly 35 years ago, but came to Oklahoma and switched to oil in 1915, then joined Deep Rock in 1920. He is credited with pioneering the use of electricity for drilling and pumping, and with the early installation of modern pumping units in Oklahoma oil fields.

Houy attended Schreiner Institute and the University of Texas before he began as a roughneck with Humble Oil & Refining Company in Texas fields 14 years ago. In 1940, he joined Republic Natural Gas Company at Dallas as engineer and steadily progressed until he was vice president of the gas division and had charge of all the company's engineering and drilling at the time he joined Deep Rock in 1950.

•

Gus S. Wortham, Houston, has been elected a member of the board of directors of Texas Eastern Transmission Corporation, to succeed the late **E. Holley Poe** of New York. Wortham is president and director of American General Insurance Company and vice chairman and director of American General Life Insurance Company of Houston.

John E. Swearingen has been elected a director of Stanolind Oil and Gas Company. Swearingen has been with Stanolind since 1947, most of the time in the Tulsa general office. For 13 months, he was manager of the company's Central division with headquarters in Oklahoma City, returning to Tulsa in February. Before joining Stanolind, he was with Standard Oil Company (Indiana) for eight years. Swearingen was graduated from the University of South Carolina in 1938 with a B.S. degree in chemical engineering, and a year later received an M.S. in chemical engineering from Carnegie Institute of Technology, Pittsburgh.

J. E. Swearingen

•

Richard D. Montgomery, manager of the Exploitation department of Richfield Oil Corporation since 1937, has been elected a vice president of the corporation. He will direct Richfield's drilling, production and gas department operations. A veteran of more than 35 years in the industry, he has been with Richfield since 1926, when he became head of the Land department. In 1931, he took charge of production, land and engineering, continuing in that post until he became manager of the Exploitation department.

R. D. Montgomery

Montgomery received a degree in mining engineering at the University of California in 1911. He was with independent oil companies operating in the Taft and Maricopa districts of Kern County, California, from 1911 to 1913, after which he was engaged in mining in the state of Durango, Mexico, until 1916. Montgomery was with Standard Oil Company of California from 1916 to 1926, during which time he served as a field engineer in Whittier, Calif., resident engineer in Bakersfield, Calif., and engineer in charge of development in Brazil, Panama, Costa Rica, Colombia, Ecuador and Venezuela.

•

J. H. Thacher has been appointed executive assistant to the vice president of Standard Oil Company of California. Thacher, formerly Standard's Southern district producing manager, will handle work in connection with the company's Elk Hills operating contract with the Navy.

Other appointments in the Producing department are those of **W. C. Johnson** as manager, Southern district; **M. W. Morris**, general superintendent, Southern district; and **K. B. McNamara**, district petroleum engineer, Southern district.

•

Robert B. Clark has resigned as petroleum engineer for Texas Gas Transmission Corporation, Owensboro, Ky., to enter consulting work with **Chester C. Clark**, geologist, 302 Petroleum Building, Shreveport.

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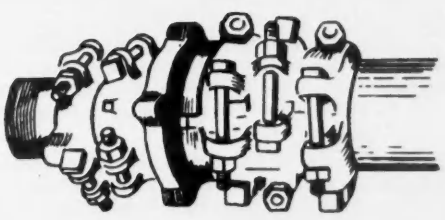

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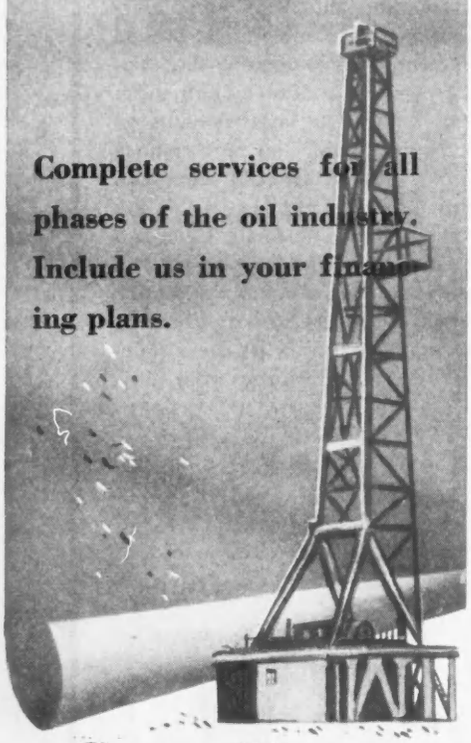

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MEN IN THE INDUSTRY NEWS

Frank T. Clark

Frank Cooter

Frank T. Clark has been appointed chief geologist for Cities Service Oil Company (Del.) **Frank Cooter** has been named to the new position of exploration field division manager.

A. E. Dietert has been appointed division geologist at Fort Worth, succeeding Clark. **Norman W. Ewbank** succeeds Dietert in the Bartlesville geological office.

Clark joined the company in 1924 as Kansas division geologist. After serving 11 years in this position he was transferred to San Angelo as West Texas district geologist. He also served as division geologist at Odessa, Texas, was transferred to the Houston division office, and, in 1948, was named division geologist in the Fort Worth Office.

Cooter steps into his new position after serving as division landman at Fort Worth for three years. He was first employed by the company as landman in 1928. His work for Cities Service covered the Mid-Continent and Mississippi areas. In 1948 he was appointed division landman at Fort Worth.

Dietert joined Cities Service in 1929 as scout at Seguin, Texas. He was transferred from the field to the Bartlesville office in 1935 as geophysicist and was appointed division geologist there in 1941.

Ewbank has been with Cities Service since 1948, serving in the Houston and Midland geological offices before being transferred to Bartlesville. He is a graduate of the University of Texas, and before joining Cities Service was with a commercial seismograph company.

•

E. J. Nicklos has been elected chairman of the board of Nicklos Drilling Company, Houston, and has been succeeded as president by **Donald E. McMahon**, who was formerly vice president.

Nicklos' career in the oil industry began in 1901, when he was superintendent and manager of an oil field in Galicia, Austria. He worked in Croatia from 1905 until 1907, when he became general manager of Anglo-Mexican Oil Fields, Ltd., in Tampico, Mexico. For nine years, 1913-1922, he was an independent drilling contractor in Tampico. Nicklos went to the U.S. in 1923 as division superintendent in the Production department of The Texas Company. He resigned in 1928 to join Continental Oil Company as vice president in charge of production, a position he held until May, 1935, when he founded Nicklos Drilling Company.

McMahon, who joined Nicklos Drilling Company when it was organized, worked his way up to the top executive position. He first entered the oil business in 1930, in the Geological department of Continental Oil Company in Canada. He was assigned to Calgary, Alberta, and later transferred to Ponca City, Okla., where he worked until he joined Nicklos. McMahon attended the University of Alberta at Edmonton.

•

W. H. Kraft has been elected a director and vice president, and **F. M. Cole** was elected a vice president of Honolulu Oil Corporation. Kraft was employed by Honolulu in 1925 and has been in charge of all gas and gasoline operations of the company in California and the Mid-Continent for more than ten years. Cole joined the company in 1937 and has been assistant to the executive vice president since 1947.

•

Jack L. Roach has been appointed manager of the Land and Exploration Service department of Deep Rock Oil Corporation. Roach has had 12 years' experience in geological and drafting work for The Pure Oil Company in Tulsa.

•

Cecil A. Hamman, formerly with Yingling Oil and Mining Company, is now a consulting petroleum engineer at Evansville, Ind.

•

Joseph E. Morero, chief geologist, Skelly Oil Company, Tulsa, has been elected vice president in charge of the Geological department. **A. L. Cashman** was elected vice president in charge of the Land and Lease department.

•

Charles T. Reichert, division sales manager of The National Supply Company's Oil Field Machinery and Equipment Division, Torrance, Calif., has taken leave of absence to accept a post with the Petroleum Administration for Defense. Reichert has been named chief of the Drilling and Production section of the Material division of PAD, charged with determining the material required to drill the 43,400 new wells planned by the petroleum industry in 1951. The division will also determine the material requirements of the nation's present 500,000 oil and gas wells and later allocate materials.

C. T. Reichert

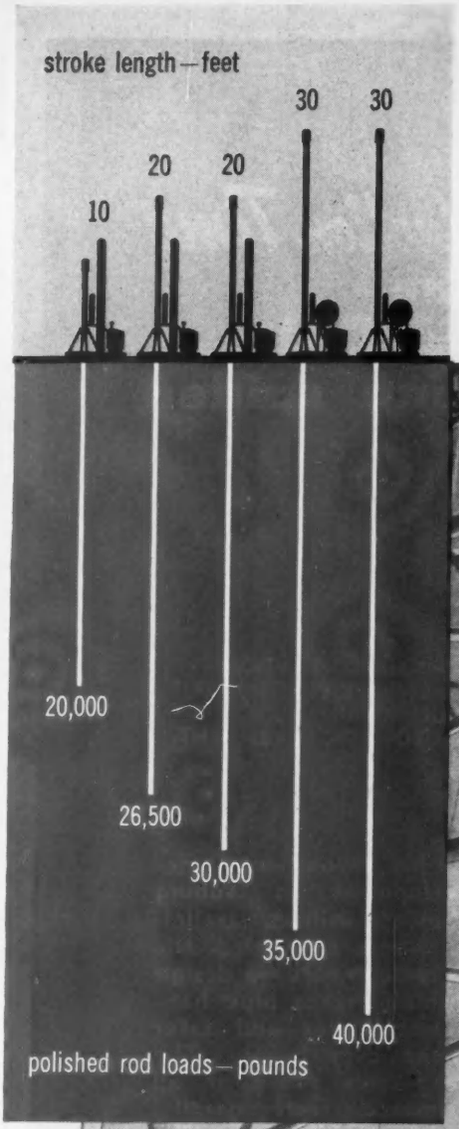
•

Ray C. Lewis, formerly chief geologist, has been appointed to the new position of manager of exploration in charge of the Geological, Geophysical and Land departments of Houston Oil Company of Texas. He is succeeded as chief geologist by **Wendell L. Lewis**, formerly staff geologist.

Ray Lewis was graduated from the University of California and worked for Stanolind Oil and Gas Company in the Geological department before joining Houston Oil Company as chief geologist in July, 1945.

Wendell Lewis was employed as a field geologist following his graduation in geology from the University of Nebraska, and has been with the company since May, 1941.

a PELTON long stroke hydraulic pumping jack for every application



The production of more oil at less cost is the sole purpose of the PELTON Long Stroke Hydraulic Pumping Jack.

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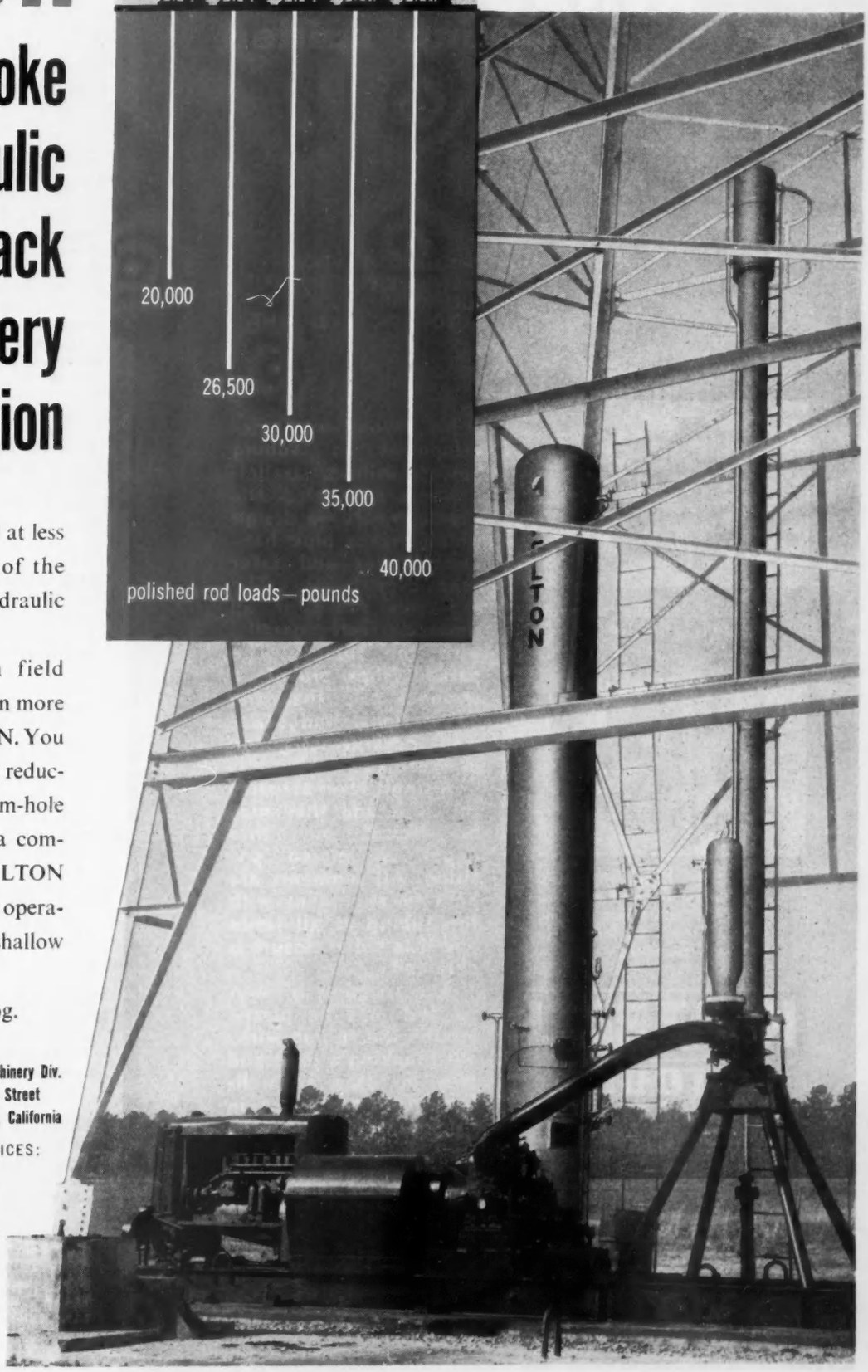

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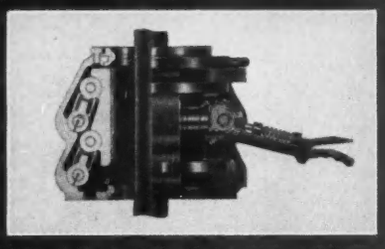
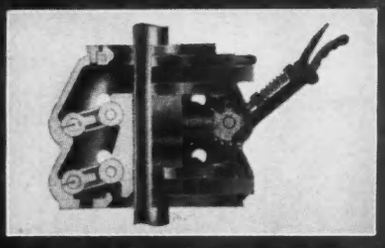


Running in. Slip segments are fully retracted



Slip Set. Note that slip segments are still parallel with the centerline of the pipe. Handle is locked in "closed" position.

This revolutionary development in Tubing Spiders, utilizes parallel-linkages to control the slip segments—a design which makes pipe handling faster and safer than ever before. The segments move at all times perfectly parallel with the tubing. The parallel slips provide a stronger grip than the conventional wedge design and will not gouge or score the tubing.

A single lever actuates the slips and they may be locked in either "open" or "closed" position. All segments are held in alignment with the tubing at all times and true radial closure is obtained.

The assembly is hinged and may be placed around the tubing without breaking a joint and may be used on wellhead fittings or set in the rotary bushing.

For complete information write for Bulletin 23151.

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DEATHS

Jack C. Jones, 45, general superintendent of Humble Pipe Line Company, Houston, died May 22. Jones had been with Humble Pipe Line since 1928, two years after being graduated from Texas A. & M. College. In January, 1939, he was made district pipe line superintendent at Pampa, and from 1942 until 1949 he was assistant division pipe line superintendent at Midland. He became superintendent of field operations in 1949, and was made general superintendent in 1950.

•

William D. Blackburn, 72, geologist, mining engineer and rancher, died May 6 in Houston. Blackburn was graduated from the University of Texas about 1902. He went to Mexico as a mining engineer, returning to Texas in 1912. He moved to Houston in 1918, and was a civil engineer before joining Humble Oil & Refining Company as a geologist in 1920. Seven years later he went to Fort Worth as chief geologist for Snowden & McSweeney, independent oil operators. He remained with that firm until 1933, when he re-entered the mining engineering field. He retired from active business in 1936.

•

John H. Edwards, Sr., 80, pioneer Oklahoma oil operator, died May 6 in Tulsa. He was credited with opening up the first shallow oil pool in Rogers County, Oklahoma, and had lived in Tulsa since 1912.

•

Alph Tillman, 63, independent oil operator, died April 30 in Dallas. Tillman's oil operations extended to many points in Texas and Oklahoma, and he was particularly active in Hunt County, Texas.

•

Stanley Gill, 51, consulting petroleum engineer, died May 7 in Houston. Gill was graduated in 1920 from the University of Washington with a B.S. in chemical engineering. He did graduate work at Columbia University and served on the faculties of both Columbia and Mellon Institute of Industrial Research. He was employed by Gulf Oil Corporation in Houston in 1924. In 1932 he opened his offices as an independent consultant. Gill was the author of several books on oil production, and had served as a consultant on petroleum problems for the Canadian government.

•

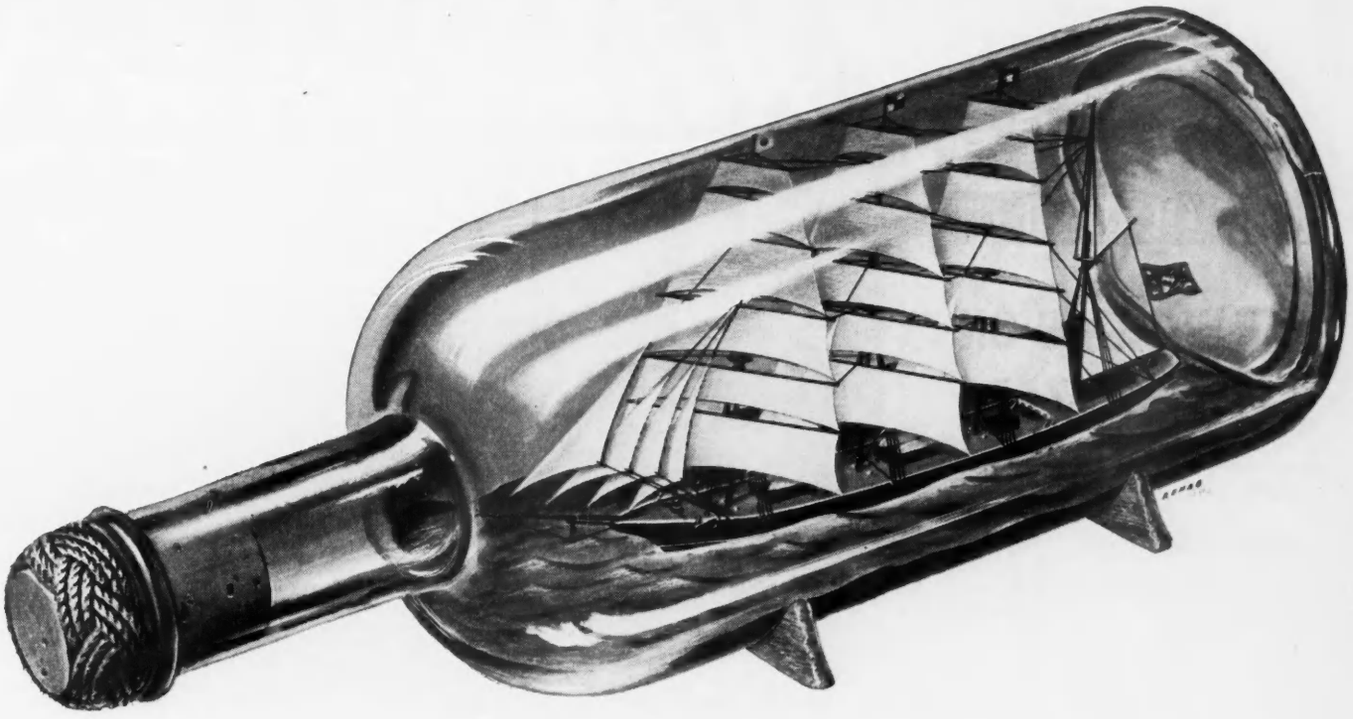
H. H. (Scotty) Taylor, Fayetteville, Ark., independent oil man and former newspaper man, died April 18 in Mineral Wells, Texas. He was active in early oil development at Seminole, Okla.

•

Edward F. Nolan, 61, formerly purchasing agent for the Material and Traffic department, The Carter Oil Company, Tulsa, died April 26. He retired in 1949 after 30 years' service with Carter.

•

John Cummins Miller, 55, consulting geologist, died May 2 in Houston. Miller was graduated from the University of Kentucky and received his master's degree in geology from Columbia University. He was a member of Houston Geological Society and AAPG.



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THIS example of craftsmanship symbolizes something that every producer of quality line pipe must know: *Painstaking care is essential.*

Such craftsmanship is fundamental at Kaiser Steel, where every step in production is completely and rigidly controlled. The result is steel pipe which measures up to the precise specifications of the gas, oil and water industries.

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Kaiser Steel Pipe is manufactured to conform to latest API specifications—in diameters from ½ inch to 30 inches, and in lengths up to 55 feet. Shipping points are Fontana and Napa, California.

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Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5⅝" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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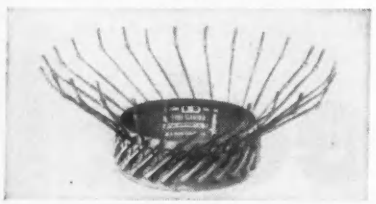

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Associations

New Eastern District Officers of the API Division of Production are, left to right, front row, Jack Cashell, vice chairman, Preston Oil Company, Columbus, Ohio; E. T. Heck, chairman, Quaker State Oil Refining Company, Bradford, Penn.; and Marshall Joy, vice chairman, Brazos Oil Company, Mount Pleasant, Mich. Back row, K. C. Cottingham, chairman of the advisory committee, Ohio Fuel Gas Company, Columbus; R. L. Bird, Jr., secretary-treasurer, Columbian Carbon Company, Charleston, W. Va.; and E. E. Roth, vice chairman, Columbia Engineering Company, New York. Vice chairmen not pictured are Paul Benedum, Hiawatha Oil Company, Pittsburgh; R. W. French, Sohio Petroleum Company, Cleveland; John T. Galey, independent producer, Pittsburgh; and T. C. Stauffer, Sun Oil Company, Evansville, Ind.

Desk & Derrick Representative Attends World Oil Congress

Mrs. Lucille Taylor of Houston will bring back from Europe late in June both world petroleum news and motion pictures covering the Third World Petroleum Congress to members of the Desk and Derrick Clubs of North America. Mrs. Taylor was selected by Lee Wilson, president of the association, to represent the club at the Petroleum Congress in The Hague, Netherlands, Holland, May 28 through June 6. Following adjournment of the congress she is touring several European countries for the purpose of gathering interesting information and color pictures.

Mrs. Lucille Taylor

Mrs. Taylor is secretary to L. M. York, president of York Supply Company, Houston.

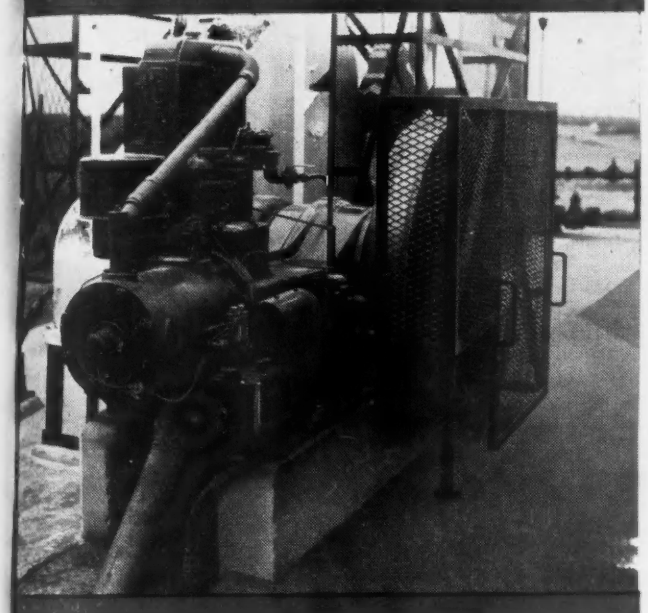
PAD Officials Will Address Equipment Suppliers' Meeting

Three officials of the Petroleum Administration for Defense will address the Petroleum Equipment Suppliers' Association when it meets at the Chateau Frontenac, Quebec, June 17-20.

Speaking and presiding over a question-and-answer period Monday afternoon, June 18, will be Frank Watts, director, Materials division; Richard G. Lawton, director, Production division; and George Oller, chief, Equipment Manufacturers branch.

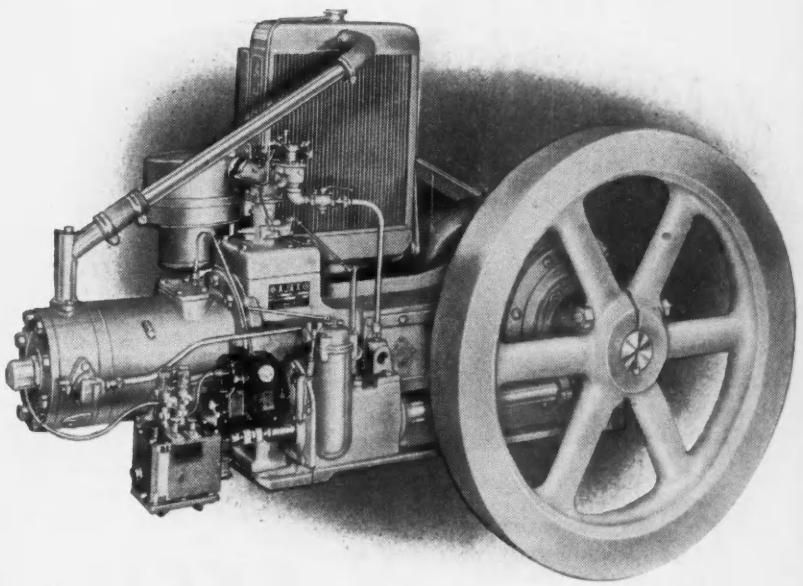
On Tuesday, June 19, the meeting will be addressed by Dr. John A. Krout, dean of graduate facilities and associate provost of Columbia University.

Southern Gas Association officers for 1951 are, left to right, Kyle Turner, Atlanta Gas Light Company, assistant secretary; H. V. McConkey, Southern Union Gas Company, treasurer; H. K. Griffin, Mississippi Gas Company, second vice president; L. L. Dyer, Lone Star Gas Company, president; J. H. Wimberly, Houston Natural Gas Company, first vice president, and C. H. Zachry, Southern Union Gas Company, vice chairman of the advisory council.



CHOSEN BEST

by *Comparative Test!*



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Every month, more of the steady stream of AJAX Engines rolling to every field are *ordered on the basis of exacting comparative performance analyses.*

In every instance that has come to our attention, where careful checks have been made on operating economy, maintenance costs, ease of servicing and all-around dependability—*AJAX leads.* Such tests confirm the practical experience of Ajax users everywhere. Talk it over with your Supply Man!

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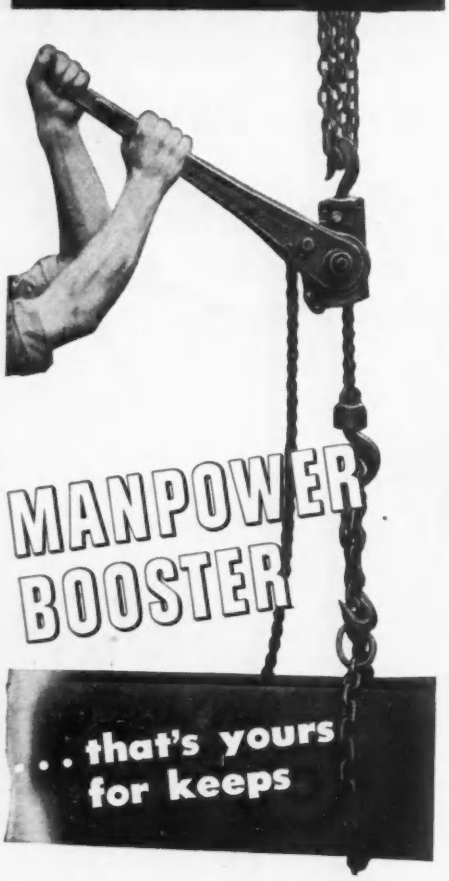

Meet the increasing demand on available manpower with Coffing Safety-Pull Hoists. Here are mechanical muscles that are bought, not hired — and they're yours for keeps. With a Safety-Pull to relieve the burden of countless lifting, pulling jobs, more skilled effort is applied where it pays—in production.

Safety-Pulls work efficiently any place — indoors or out, vertically or horizontally. To assure long life, to protect your men and materials, each is factory tested at 100 percent overload. Start now to get the most from available manpower by enlisting the help of dependable Coffing Safety-Pull Ratchet Lever Hoists. Nine sizes with capacities from 1,500 to 30,000 lb. Write for Bulletin O6SP.

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ASSOCIATIONS

Lorehn and Word are Named to Top Posts of National Nomads

By unanimous vote of fellow regents of the Dallas-Fort Worth, Houston, Los Angeles, New York and Tulsa chapters of Nomads, Edmond L. Lorehn, executive vice president of Cameron Iron Works, Houston, was elected chairman of the Nomads national board of regents. Tracy T. Word, Jr., sales manager, Well Equipment Manufacturing Company, Houston, was named secretary-treasurer.

Tracy T. Word, Jr.

Edmond L. Lorehn

They succeed Fred C. Ripley, Jr., International Derrick & Equipment Company, Torrance, Calif., and Lee J. Laird, Baash-Ross Tool Company, Los Angeles.

Lorehn went to work in the oil fields in 1918 as roustabout, roughneck and toolpusher for J. S. Abercrombie. In 1920 Abercrombie purchased the then small Cameron Iron Works and appointed Lorehn manager. Lorehn became secretary-treasurer when the company was incorporated a few months later, and in 1928 he became vice president and general manager, in addition to his duties as secretary-treasurer. In 1950 he was appointed executive vice president. He has been a member of Nomads since 1941, having been elected to membership soon after the Houston Chapter was organized.

Son of the founder of one of the first independent oil well supply organizations on the Gulf Coast, Word actively entered the oil equipment supply business in 1935 as a member of the sales organization of the T. T. Word Supply Company. He later worked for other supply organizations on the Gulf Coast and joined the WECO sales organization in 1944.

Cooley Becomes Tulsa Nomads President to Succeed Roberts

H. M. Cooley has been elected president of the Tulsa Chapter Nomads to succeed Amos A. Roberts, who was transferred from Tulsa to Houston for Baroid Sales Division, National Lead Company. Other officers who moved up to new positions are G. F. Coons, vice president; R. E. Kirberger, secretary; Gilbert Swift, assistant secretary; J. S. George, treasurer; Arch Campbell, assistant treasurer; R. C. Glover, sergeant-at-arms; and W. H. Riggins, deputy sergeant-at-arms.

AIME Moves Dallas Office

The Petroleum Branch, AIME, has moved its Dallas headquarters to 408 Trinity Universal Building. Publication offices of the *Journal of Petroleum Technology* are at the same address.

SYCO "Hard Hole" CHOKES--

Save Money--Last Longer!

"Hard Hole" CHOKES, Types A, B and C, were specifically designed for long life. Manufactured of heat treated tool steel, they are corrosion and abrasion resistant. The cost of HARD HOLE CHOKES is in keeping with conventional chokes.

Features:

"Hard Hole" Chokes pay for themselves in service and wear.

They simplify warehousing and handling as the Type "A" Choke with a simple adapter will fit practically all types of popular Christmas Trees.

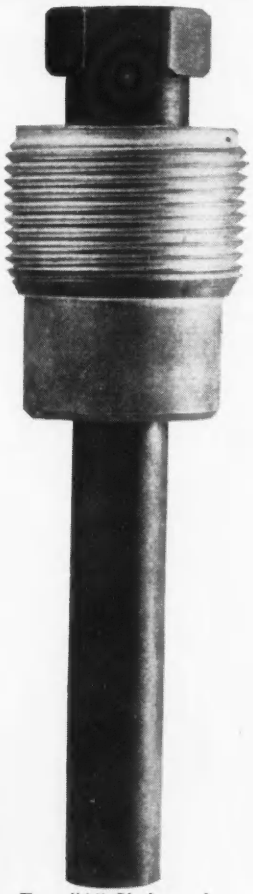
Type "B" was developed to fit flow wings to which Type "A" is not adaptable.

Proved in use by major operators for the last four years.

A complete size range is available. We specialize in the solution of choke problems.

Write, wire or phone for literature or additional information.

THE ROGER SMITH COMPANY
3820 Winchester Street, Houston, Texas Phone: FA-3055
"Sold through your Supply Store"



Type "A" Choke and No. 1 Adapter.

Unit Rig has never had a parts replacement job that couldn't be done on the rig floor! Old parts may be removed and new parts installed right on the rig floor, because there are no press nor shrink fits that require special equipment.

Extremely close machine tolerances and repeated inspections assure quick and easy fitting without filing, grinding, welding or re-machining.

Prompt delivery of *parts that fit* is one more reason why you save time and money when you own Unit Rig equipment. Make your next drawworks a Unit Rig.

UNIT RIG & EQUIPMENT CO.
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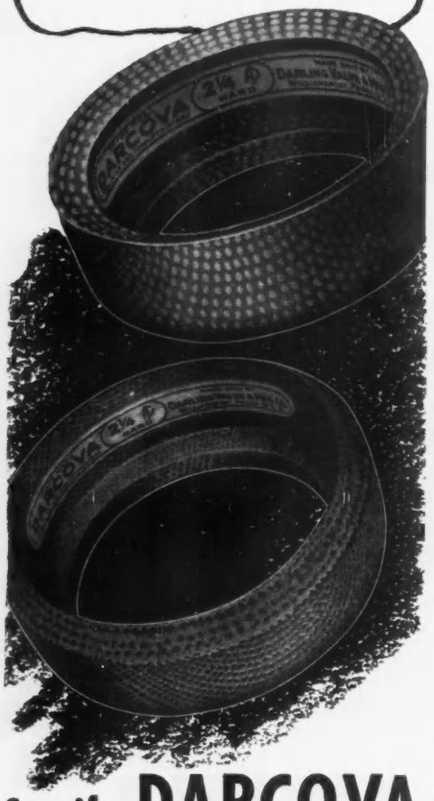

Specify **DARCOVA**

valve cups, seating cups and rings

The Original composition valve cup ... still the best!

• Precise control of all materials and processes from lab to well means exceptional resistance to wear and deterioration . . . fewer pulling jobs! • Different textures, scientifically developed, fully proved, give peak efficiency and longer flex-life at *any* depth! • Accurately controlled sizes for any make or size pump . . . no misfit inefficiency! • Ask for *genuine* Darcovas at your supply store.

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DARCOVA — THE ORIGINAL COMPOSITION CUP

Companies in the News

TEXAS EASTERN TRANSMISSION CORPORATION stockholders have approved an amendment which would permit Texas Eastern to engage directly in operations for the development of oil and gas production and reserves.

•

GENERAL PETROLEUM CORPORATION, Los Angeles, has received a top honor from the National Committee on Films for Safety, for its film, "And Then There Were Four." The movie was chosen as an outstanding non-theatrical accident prevention film in 1950 in the traffic and transportation class.

•

THE OHIO OIL COMPANY won awards in three departments in the Petroleum Section of the National Safety Council's 1950 Safety Contest. During the year, the company operated with the lowest lost-time accident record since 1927, according to **J. C. Askam,** safety manager of the company. One of the awards went to the Producing department, which received a certificate in recognition of outstanding achievement in reducing the frequency of disabling injuries.

•

LION OIL COMPANY, El Dorado, Ark., has opened a land and geological office at Amarillo, Texas, with **R. C. Martin, Jr.,** formerly of Abilene, Texas, as district landman, and **Eugene Maxwell,** formerly of Wichita, Kansas, as district geologist. **Giles E. Bradford, Jr.,** replaces Martin as district landman at Abilene.

CONTINENTAL OIL COMPANY has established its Utah-Nevada geological offices in Salt Lake City, with quarters on the sixth floor of the Newhouse Building. **John N. Huber** is in charge of the offices. The division staff moved to Salt Lake City from Elko, Nev., in order to be in a more strategic location for the company's operations in the two states, Huber said.

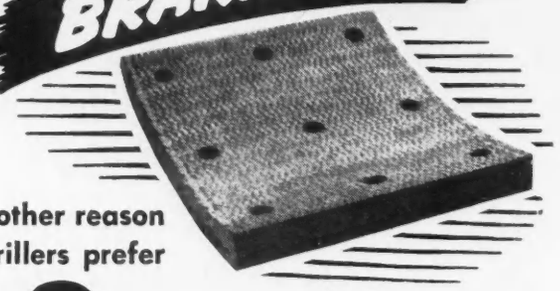
Huber, who has been with Continental since 1940, when he joined the company as a geologist in the Los Angeles offices, is a graduate of the University of California at Los Angeles. He moved to Elko early in 1950 and was promoted to division geologist later in the year.

Other geologists in the new office are **P. R. Patten, J. R. Sanders, L. W. Heiny, J. J. Haverfield** and **E. G. Johnson,** all formerly of Elko. **J. M. Saunders,** formerly in the Rocky Mountain region offices in Denver, moved to Salt Lake City to coordinate geological operations in the eastern part of Utah.

•

CLAUD B. HAMILL, Houston independent oil operator, has opened an exploration office in Midland, Texas, for operations in the Midland Basin. **Robert Doyle,** formerly a geologist with Shell Oil Company, is division manager and heads the Geological department. **Harris Houston** heads the Land department of the new office, which will be in the new Jack Wilkinson Building when it is completed.

SMOOTHNESS OF BRAKING...



. . . another reason why drillers prefer

Standco NO-SMOKE BRAKE LINING

There's no grabbing when Standco Lining is used. It has a nice feed-off and slight lever pressure controls the heaviest strings of pipe.

More deep wells have been drilled with Standco than with all other blocks combined.

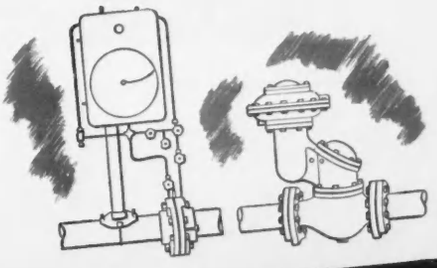
Be sure Standco No-Smoke Brake Lining is on all your rigs.

STANDCO BRAKE LINING COMPANY

Factory and General Offices

2701-2801 Clinton Drive **Houston, Texas**

SOME EASTERN SEABOARD REGIONS NOW RECEIVING NATURAL GAS THROUGH AMERICAN METER COMPANY EQUIPMENT



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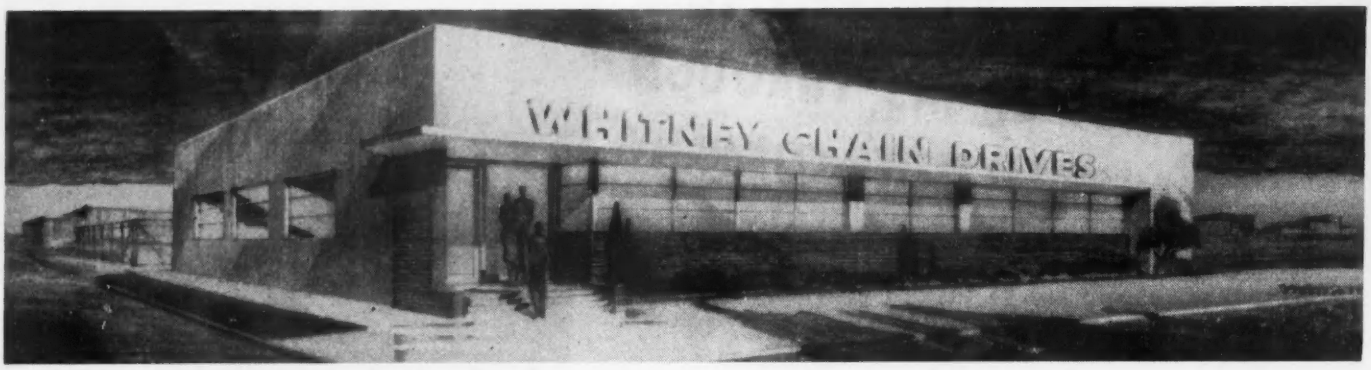
7. Meter Runs
8. Orifice Fittings
9. Differential Valves
10. Controllers, Pressure
11. Controllers, Flow
12. Temperature and Pressure Recorders

EQUIPMENT AND SERVICE SUPPLIERS' NOTES



Whitney Chain Company's new office and warehouse building in Los Angeles.

Whitney Chain Company Establishes Sales-Service Branch in Los Angeles

Whitney Chain Company, Hartford, Conn., is now serving western industries from its new office and warehouse building at 5400 Pacific Boulevard, Los Angeles.

Under the direction of A. J. Swisler, district manager, the new headquarters will function as the enginering sales and service outlet for the complete line of Whitney power transmission and conveying chain, couplings, keys and sprockets throughout Southern California and Arizona, with facilities for giving emergency service to all Pacific Coast points.

Petroleum Pioneer Joins Kobe In Perforated Sales Department

John Augsberger, who has been associated with the petroleum industry for 48 years, has joined the Perforated Sales department of Kobe, Inc. Augsberger has worked in most of the oil fields in the U. S., since his first job as a roustabout in the Geneva, Ohio, field in 1903. He worked in the booms in Illinois (1906), Indian Territory (1907, Orcutt and Midway-Sunset in California and then, later, Signal Hill. He was in charge of producing oil wells in Trinidad, British West Indies, and brought in the first producing well in Cuba. He was in the Electra, Texas, boom and, at various times, was in charge of operations on wildcats in Montana and Wyoming. Augsberger returned to California in 1922 and was in charge of Lang-Wall Corporation's Signal Hill developments until 1927 when he joined Arthur N. MacCrate as general manager. He was in this position for 22 years.

A. P. I. PIPE COUPLINGS

All Sizes and Types for Oil Field Use

LINE PIPE COUPLINGS A.P.I.
1/8" to 12"—Seamless and Special Processed—Black or Galvanized

PLAIN TUBING COUPLINGS A.P.I.
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EXTERNAL UPSET TUBING COUPLINGS A.P.I.
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HYDRAULIC COUPLINGS
1/8" to 3"—Seamless

REAMED AND DRIFTED A.I.S.I.
3/4" to 12"—Seamless or Spl. Processed

DRIVE PIPE COUPLINGS
3/8" to 12"—Seamless or Spl. Processed

Consult Our Nearest Quick Service Sales Office:

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Erie, Pa.—R. J. Maggi, Box 711
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Los Angeles—James A. Riordan Co., 1400 Santa Fe Ave.
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WHEELING MACHINE PRODUCTS COMPANY

ELM GROVE STATION — WHEELING, W. VA.

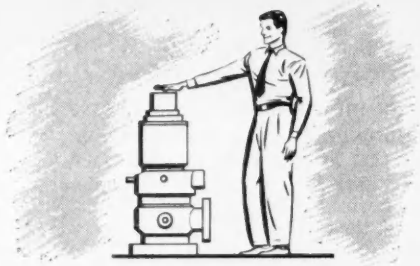
The finest in AUTOMATIC Pressure Control for modern drilling!

The Shaffer Combination Rotating Blowout Preventer and Stripper

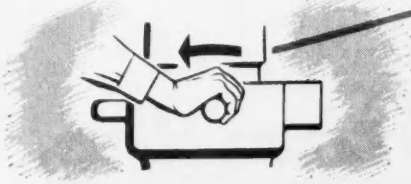
...stands alone in the pressure control field because nothing else approaches its wide-range versatility—its unique simplicity—*or its positive dependability!*

With this unit there's nothing to operate—nothing to remember—nothing to forget. It *automatically* seals off around the drill string as soon as the tools are lowered into the well—*and maintains—without attention—its pressure-tight seal throughout all subsequent drilling and pipe-changing operations.* It is always ready for any pressure emergency that may occur, whether drilling or while running pipe in or out of the well!

Here, step-by-step, you can see how the Shaffer Combination Rotating Blowout Preventer and Stripper gives positive protection during every phase of modern drilling procedures...

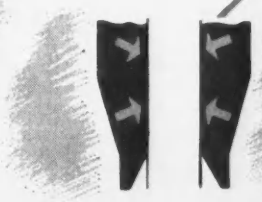


1 **NOTE THE COMPACTNESS** of the entire unit, reducing height and width requirements to a minimum and permitting installation even under difficult space limitations. Even the flow connections are incorporated into the body, eliminating need for spools or other extra equipment.

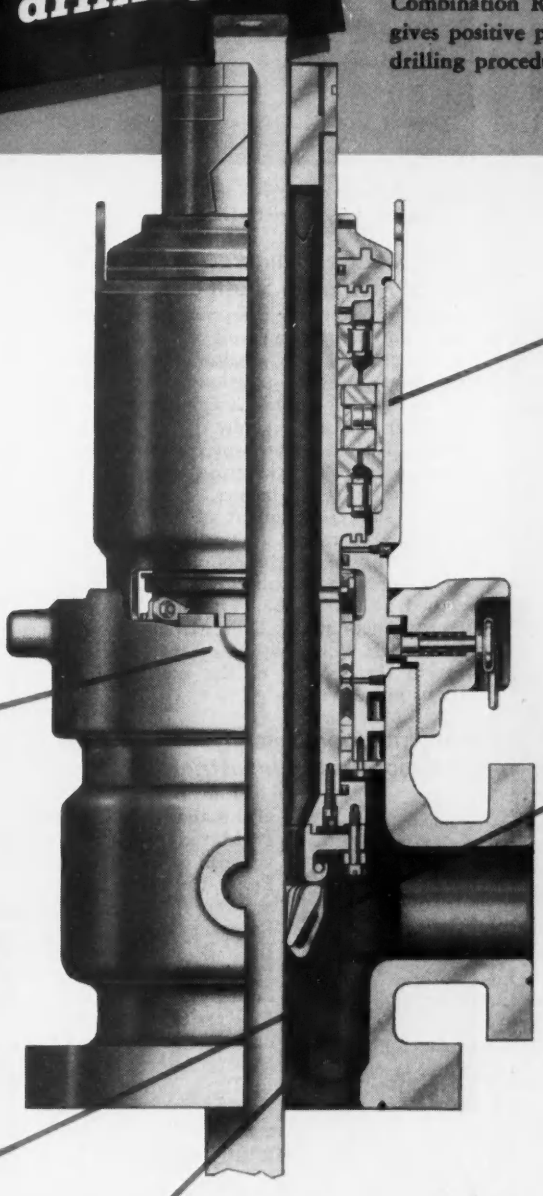


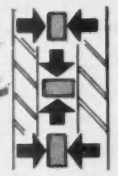
2 **CHECK THE SIMPLICITY** with which the bit and reamers are passed through the unit into the well. Simply lower the tools into the well, seat the rotating assembly in the body and rotate the bonnet 1/6 turn. The entire internal mechanism is then locked into operating position and sealed against any pressure until the tools are again removed from the well.

3 **THE VARYING DIAMETERS** in the drill string—drill collars, subs, couplings, tool joints and drill pipe (whether upset, flush, or coupled)—all pass readily through the unit without losing the pressure-tight seal because the Stripper Rubber *automatically* expands and contracts to pass them. Even the kelly—whether square, hexagonal or octagonal—is fully sealed by the Stripper Rubber *without manual adjustments of any kind!*



4 **PROTECTION AGAINST PRESSURE IS CONTINUOUS**—not only while running the varying shapes and diameters of the drill string into the well—but also throughout all rotating operations, whether forward or reverse. No mechanical or hydraulic pressure of any kind need be applied from the outside—nor are any adjustments necessary in the unit to maintain the seal during the various operations of drilling or of going into or coming out of the well.





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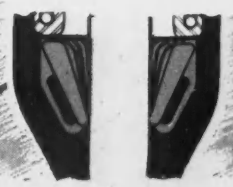

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Get full details on the Shaffer Combination Rotating Blowout Preventer and Stripper from your nearest Shaffer representative—or write direct!

Send for your free copy of the new Shaffer catalog.

See pages 4525 to 4600 of your 1951 Composite Catalog!

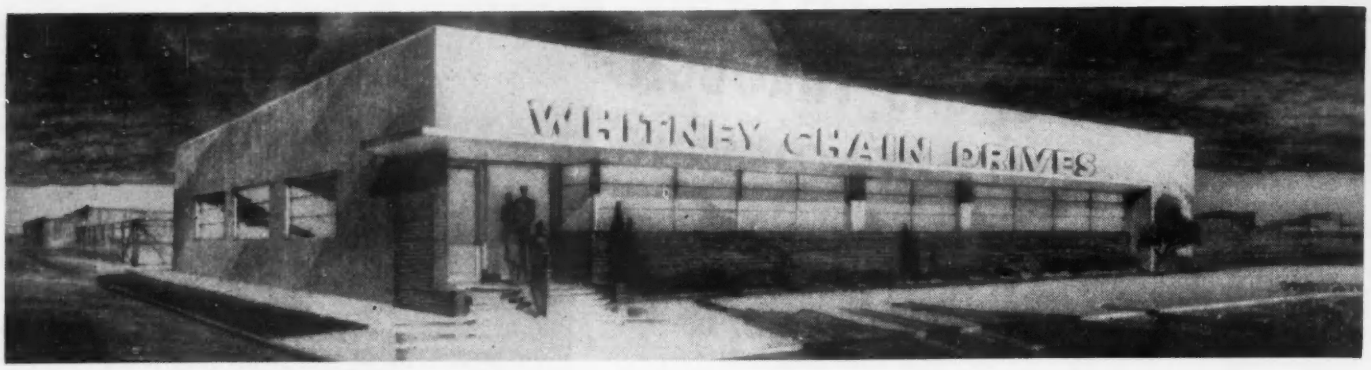
28 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS, Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

EQUIPMENT AND SERVICE SUPPLIERS' NOTES



Whitney Chain Company's new office and warehouse building in Los Angeles.

Whitney Chain Company Establishes Sales-Service Branch in Los Angeles

Whitney Chain Company, Hartford, Conn., is now serving western industries from its new office and warehouse building at 5400 Pacific Boulevard, Los Angeles.

Under the direction of A. J. Swisler, district manager, the new headquarters will function as the enginering sales and service outlet for the complete line of Whitney power transmission and conveying chain, couplings, keys and sprockets throughout Southern California and Arizona, with facilities for giving emergency service to all Pacific Coast points.

Petroleum Pioneer Joins Kobe In Perforated Sales Department

John Augsberger, who has been associated with the petroleum industry for 48 years, has joined the Perforated Sales department of Kobe, Inc. Augsberger has worked in most of the oil fields in the U. S., since his first job as a roustabout in the Geneva, Ohio, field in 1903. He worked in the booms in Illinois (1906), Indian Territory (1907, Orcutt and Midway-Sunset in California and then, later, Signal Hill. He was in charge of producing oil wells in Trinidad, British West Indies, and brought in the first producing well in Cuba. He was in the Electra, Texas, boom and, at various times, was in charge of operations on wildcats in Montana and Wyoming. Augsberger returned to California in 1922 and was in charge of Lang-Wall Corporation's Signal Hill developments until 1927 when he joined Arthur N. MacCrate as general manager. He was in this position for 22 years.

X A. P. I. PIPE COUPLINGS

All Sizes and Types for Oil Field Use

LINE PIPE COUPLINGS A.P.I.
1/8" to 12"—Seamless and Special Processed—Black or Galvanized

PLAIN TUBING COUPLINGS A.P.I.
1" to 3"—Seamless

EXTERNAL UPSET TUBING COUPLINGS A.P.I.
3/4" to 3 1/2"—Seamless

CASING COUPLINGS A.P.I.
4 1/2" to 13 3/8"—Long or Short

HYDRAULIC COUPLINGS
1/8" to 3"—Seamless

REAMED AND DRIFTED A.I.S.I.
3/4" to 12"—Seamless or Spl. Processed

DRIVE PIPE COUPLINGS
3/8" to 12"—Seamless or Spl. Processed

Consult Our Nearest Quick Service Sales Office:

Albany, N. Y.—Albert L. Becker, 434 Clinton Ave.
Baltimore—Ted Barto, 2301 N. Charles St.
Boston—Wm. F. Bennett, 24 Spring St., Somerville
Buffalo—W. E. Spencer & Assoc's, 241 S. Elmwood Ave.
Chicago—Harry A. Jay, 122 So. Michigan Ave.
Denver—Earl H. Jones & Co., 1863 Wazee St.
Detroit—Thomas L. Osberger, 19451 Livernois Ave.
Erie, Pa.—R. J. Maggi, Box 711
Houston—Henry H. Paris Distributor, Inc., Bo 932
Kansas City, Mo.—Wm. J. Hebenstreit, 3122 Coleman Rd.
Los Angeles—James A. Riordan Co., 1400 Santa Fe Ave.
Minneapolis—Lin J. Krause, 200 Lumber Exchange
Newark, N.J.—Murray Eskin, Industrial Office Bldg.
New York—Henry Stein, 50 Cliff St.
Philadelphia—J. W. Worthington, 401 N. Broad St.
Portland, Ore.—Earl H. Jones & Co., 1933 NW 19th Ave.
Richmond, Va.—P. C. Abbott & Co., Mutual Bldg.
San Francisco—Earl H. Jones & Co., 1150 Folsom St.
Seattle—Earl H. Jones & Co., 619 Second Ave.

FACTORY 'PHONE: WOODSDALE 3296

WHEELING MACHINE PRODUCTS COMPANY

ELM GROVE STATION WHEELING, W. VA.

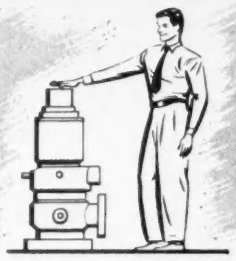
The finest in AUTOMATIC Pressure Control for modern drilling!

The Shaffer Combination Rotating Blowout Preventer and Stripper

...stands alone in the pressure control field because nothing else approaches its wide-range versatility—its unique simplicity—*or its positive dependability!*

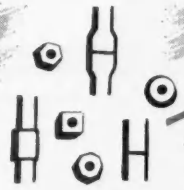
With this unit there's nothing to operate—nothing to remember—nothing to forget. It *automatically* seals off around the drill string as soon as the tools are lowered into the well—*and maintains—without attention—its pressure-tight seal throughout all subsequent drilling and pipe-changing operations.* It is always ready for any pressure emergency that may occur, whether drilling or while running pipe in or out of the well!

Here, step-by-step, you can see how the Shaffer Combination Rotating Blowout Preventer and Stripper gives positive protection during every phase of modern drilling procedures...



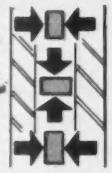
1 **NOTE THE COMPACTNESS** of the entire unit, reducing height and width requirements to a minimum and permitting installation even under difficult space limitations. Even the flow connections are incorporated into the body, eliminating need for spools or other extra equipment.

2 **CHECK THE SIMPLICITY** with which the bit and reamers are passed through the unit into the well. Simply lower the tools into the well, seat the rotating assembly in the body and rotate the bonnet 1/6 turn. The entire internal mechanism is then locked into operating position and sealed against any pressure until the tools are again removed from the well.



3 **THE VARYING DIAMETERS** in the drill string—drill collars, subs, couplings, tool joints and drill pipe (whether upset, flush, or coupled)—all pass readily through the unit without losing the pressure-tight seal because the Stripper Rubber *automatically* expands and contracts to pass them. Even the kelly—whether square, hexagonal or octagonal—is fully sealed by the Stripper Rubber *without manual adjustments of any kind!*

4 **PROTECTION AGAINST PRESSURE IS CONTINUOUS**—not only while running the varying shapes and diameters of the drill string into the well—but also throughout all rotating operations, whether forward or reverse. No mechanical or hydraulic pressure of any kind need be applied from the outside—nor are any adjustments necessary in the unit to maintain the seal during the various operations of drilling or of going into or coming out of the well.



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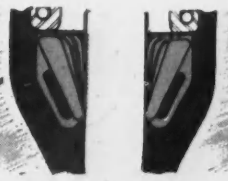

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28 years OF OIL TOOL LEADERSHIP

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

REYNOLDS Red Top Hydrostatic BAILER

This combination bailer and well tool has developed new techniques for completing low pressure wells, deepening and workover service. For drilling and removing cement and plastic plugs, and for fishing. Operates on regular wire line equipment.
See Composite Catalog for details.

Pieces of bridging plug drilled and bailed from well with Reynolds Tool.

REYNOLDS SPECIALTY CO., INC.
SHREVEPORT, LOUISIANA, U. S. A.
Office Phone 7-7511 – Factory Phone 2-2023
If no answer call 7-4966 or 2-5842
Serving La., Miss., Tex., Okla., Ark.

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SPECIALIZING IN MAGNETIC SURVEYS

Contracts accepted for domestic and foreign projects, using the most improved instrumental and interpretative technique.

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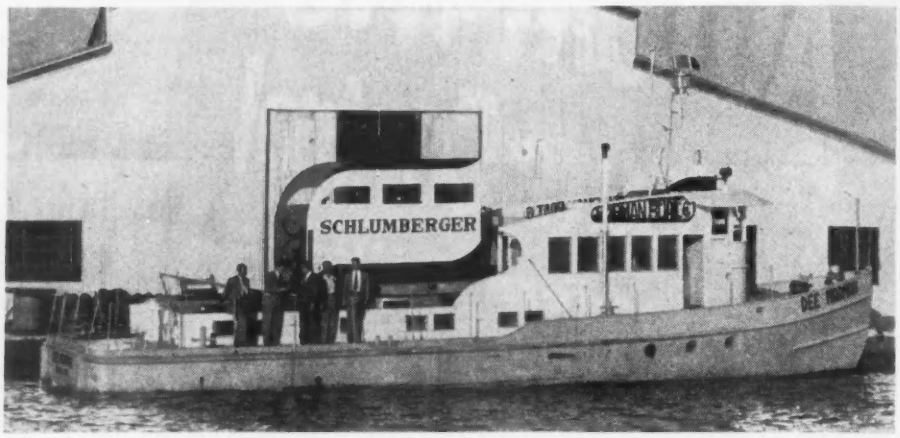
EQUIPMENT and SERVICE SUPPLIERS' NOTES



Schlumberger Well Surveying Corporation's first shallow-draft boat, shown docked in back of the Harvey, La., district office, will serve oil wells in lakes and marshes of South Louisiana.

Schlumberger Inaugurates New Well Service Method in South Louisiana

Schlumberger Well Surveying Corporation is now employing well servicing equipment mounted on a shallow draft, 64-foot steel boat, in its operations in the lakes and marshes of South Louisiana. The boat is powered by twin screw diesels and will operate in the shallow water area formerly served only by trucks transported to and from the wells by barges. The boat will carry a full complement of the electrical apparatus necessary to perform all of the services offered by the company.

The new Schlumberger boat will be berthed at Buras, La., and will be under the management of Don Mitchell, senior engineer. It will serve inland water drilling sites in the vicinty of the mouth of the Mississippi River.

Manufacturing Executive is Advanced To Major Dresser Industries Post

H. P. Boncher

H. P. Boncher, general manager of Dresser Manufacturing Division, Bradford, Penn., has been elected a vice president of Dresser Industries, Inc. Boncher joined Dresser soon after graduation from the University of Cincinnati. He was appointed assistant sales manager in 1930, promoted to sales manager in 1938, and to his present position in 1942.

Parkersburg Rig & Reel Elects Knowles Chairman of the Board

A. Sidney Knowles was re-elected president of The Parkersburg Rig & Reel Company and named chairman of the board of directors at the annual stockholders' meeting held in Parkersburg, W. Va.

As chairman of the board of directors, Knowles succeeds John M. Crawford, founder of the company, who held this position at the time of his death in July of last year.

Other officers who were re-elected are W. V. Rathbone, vice president and general manager; B. M. Farson, vice president and treasurer; A. G. Evans-Lombe, vice president, sales; R. G. De La Mater, vice president, engineering; D. C. Myers, vice president and Paul O. Summers, secretary.

Jarecki International Announces Assignments in New Organization

Jarecki International Supply Division, H. K. Porter Company, Inc., announced that Charles L. White will be general manager of the expanded organization which now includes the former Ideco Supply stores as well as the Jarecki stores.

Other appointments within the division include those of John L. Morgan, former district manager for Ideco in Louisiana and Mississippi, as sales manager; F. W. Budde as assistant treasurer; J. A. Hadlow as works accountant; W. L. Reynolds as purchasing agent; E. H. Jaynes as credit manager; Don Shaw as manager, machinery sales; and F. E. Suder as manager, pumping sales.

The expanded division operates 21 supply stores in the South and Southwest.

Standco
NO-SMOKE

STANDCO BRAKE LINING

Is the driller's best friend because it makes the easiest brake known and "feeds off evenly while drilling." It never scores brake rims. See pages 4739-4750, Composite Catalog.

Standco Brake Lining Co.
HOUSTON

IT'S NEW ..IT'S PELCO TOO!

HOUSTON LABORATORIES
Analytical and Consulting Chemists
Hydrocarbon Gas Analyses, Reservoir Equilibria Studies for Crude and Condensate well, Waters, Brines, Corrosion and Industrial Analyses.
Phone CApitol 1319, Box 132, Houston, Texas

Tip to production men

Ask your Christmas tree supplier for

UNIBOLT FLOW MANIFOLDS

PREFABRICATED AND TESTED

LESS WEIGHT

GREATER STRENGTH

LOWER COST

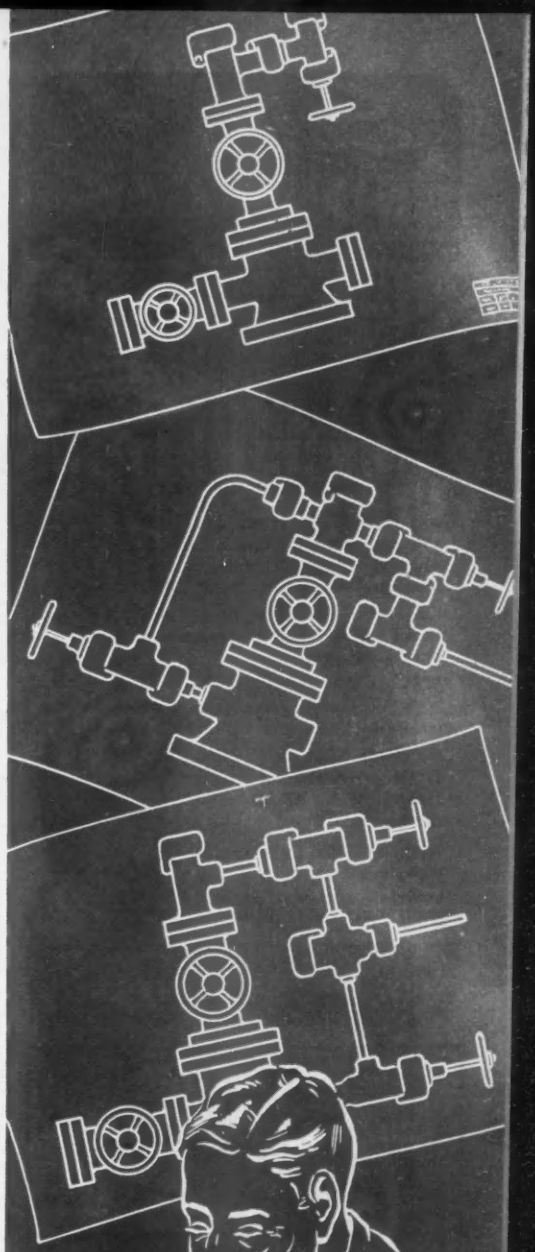
ASSURED DEPENDABILITY

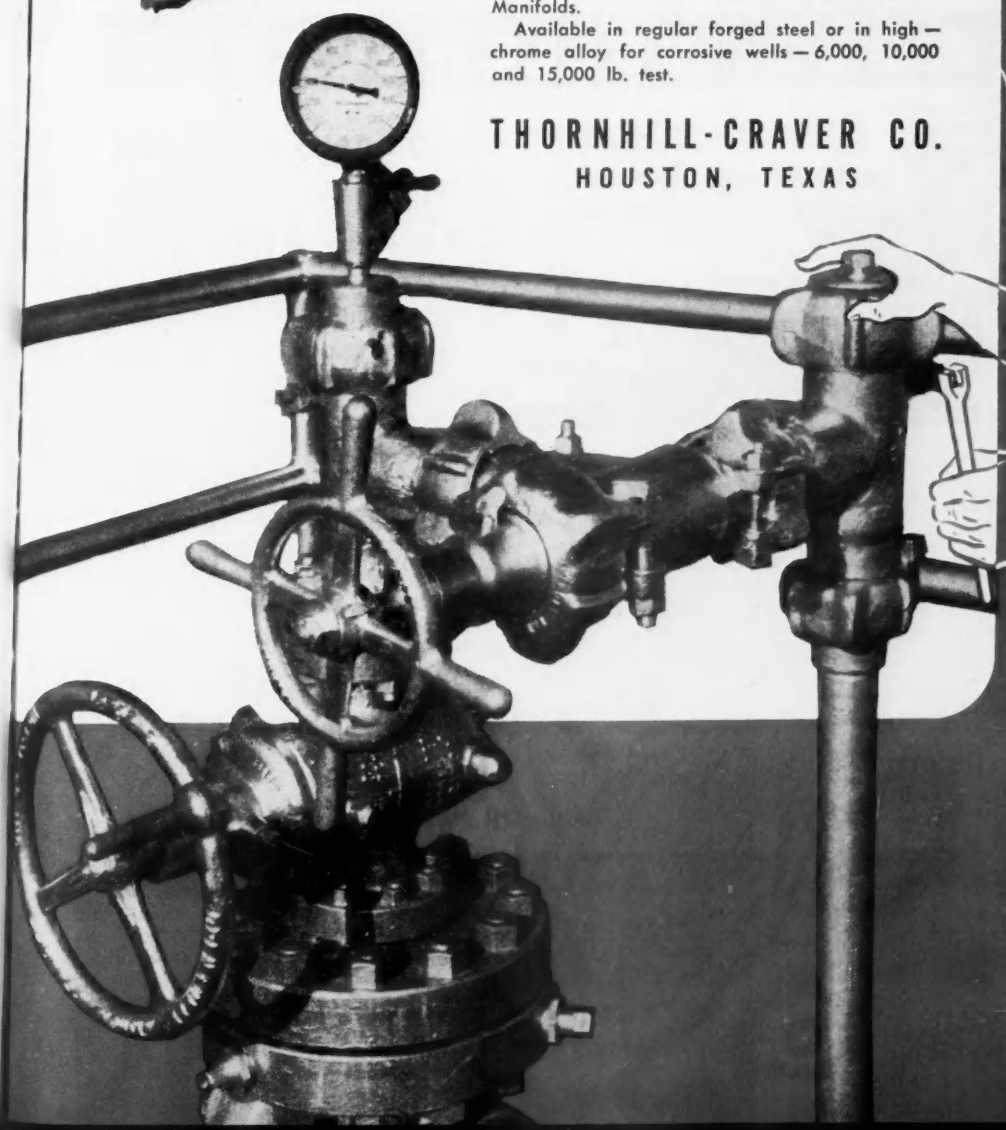
UNIBOLT Flow Manifolds are preferred by many production men because the units of this manifold — Unibolt Adjustable Wing Valve, Unibolt Positive Choke Body, and Unibolt Tee or Cross — may be assembled in a number of combinations to best meet individual requirements . . . The Manifolds are assembled to specifications at the UNIBOLT plant and tested before delivery to your Christmas tree supplier. The Wing Valves can be arranged for flowing with or against the stem, and the Positive Choke Body may be rotated to any desired position to facilitate tying-in with the flowline. It's truly flexible.

Add to this such features as: exclusive "flow-rated" positive beans (regular fractional sizes and "X" sizes) for precise control of well flow, lighter weight, greater strength, lower first cost and maintenance, plus the fact that any of its parts may be safely and easily replaced in the field, and you have the reason why more and more operators are specifying UNIBOLT Flow Manifolds.

Available in regular forged steel or in high — chrome alloy for corrosive wells — 6,000, 10,000 and 15,000 lb. test.

THORNHILL-CRAVER CO.
HOUSTON, TEXAS





Special for
SOUR GAS

STITT

SPARK PLUGS

LAST FOR MONTHS
INSTEAD OF DAYS

In every sulphur-content gas field, specially designed STITT X-series plugs have given unusual performance since 1918. Here's why:

RESISTANT ALLOY electrode and firing wires resist breakdown and disintegration

SPECIAL INSULATION has high heat conductivity, great mechanical strength

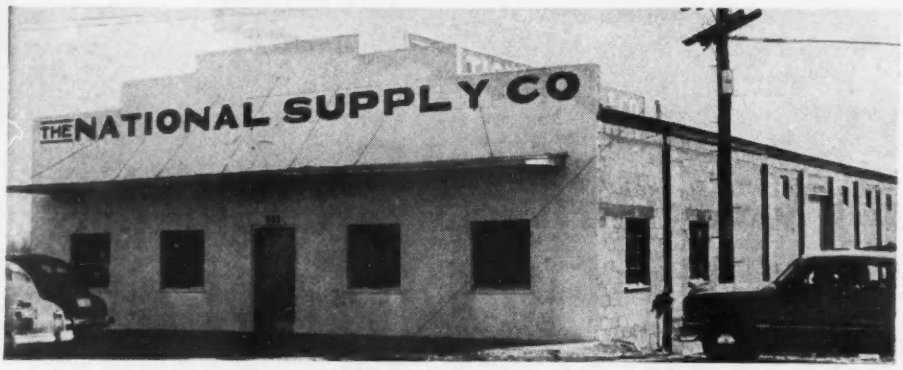
PRESSURE SEAL CONSTRUCTION prevents expansion leakage under all operating conditions

Specify STITT Gas Engine Plugs for regular or sour gas

Distributor inquiries invited . . . write Stitt Ignition Co., 86 E. First Ave., Columbus 1, O.

NOW AT YOUR SUPPLY STORE

EQUIPMENT and SERVICE SUPPLIERS' NOTES



Farmington, N. M., Headquarters of The National Supply Company are located in this new building. C. W. Morris is manager of the store, which will serve southwestern Colorado, San Juan County in Utah, and McKinley, Rio Arriba, San Juan, Taos and Colfax counties in New Mexico.

Technical Oil Tool Announces Four Changes in Field Service Staff

Technical Oil Tool Corporation has assigned Bob Green, who has been stationed at Casper, Wyo., to Los Angeles as field testing engineer. Eldon Snyder, formerly at Brookhaven, Miss., has taken over Green's former territory. Howard Reed, who has been in Houston, has moved to Laurel, Miss.

Reed has been succeeded at Houston by W. D. (Shorty) Smith, who has had oil field supply experience in Longview, Texas, and Shreveport.

All Totco field service men went to Los Angeles in April and May for a tour of the Totco plant, and updating on new equipment, manufacturing and service methods, and related technical information, according to H. H. (Pete) Peters, vice president.

Dowell Incorporated Establishes Operating Station in New Mexico

A new operating station has been opened at Aztec, N. M., by Dowell Incorporated, to offer acidizing, Electric Pilot and perforating services to operators in the San Juan Basin area.

Harry A. Riggs, Dowell sales engineer from Seminole, Okla., has been transferred to Aztec, a part of Dowell's Midland, Texas, district. Riggs is a graduate in petroleum engineering from the University of Tulsa, and has been with Dowell since 1948. Other personnel at Aztec are Floyd Bushwar, G. E. Cole and R. A. Duncan.

CONTACT YOUR FAVORITE SUPPLY HOUSE

PARMACO
PARKERSBURG MACHINE CO.
PARKERSBURG, W. VA. U.S.A.

The House of Courteous Service

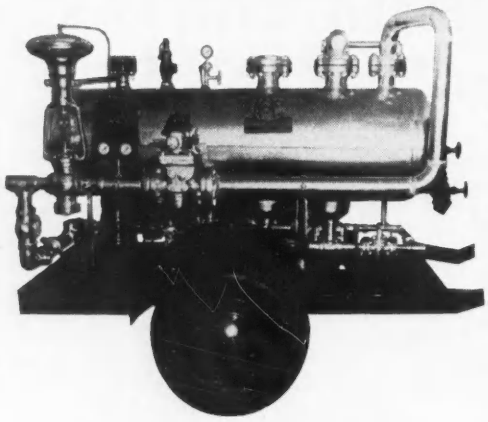
50 YEARS OF SERVICE

And on our 50th Anniversary we again invite you to Standardize on

PARMACO PRODUCTS

PARKERSBURG MACHINE COMPANY
PARKERSBURG, W. VA.

ROLO WELLCHECKERS



ROLO No. 6H—2406
6'0" s. to s.; 24" dia.; 600# w.p.; 1450 bpd. oil; 9000 MSCFD gas; 600 bpd. water.

SKID AND TRAILER MOUNTED OIL AND GAS SEPARATORS

This compact Wellchecker has facilities for metering both oil and gas. A tie-in line permits rejoining oil and gas after metering, if desired. No. 6H—2406 can also be furnished with automatic water knockout to remove and meter free water. Unit simplifies periodic well tests, gas/oil ratio tests, drill stem and potential tests. See Composite Catalog or write for Illustrated Bulletin No. 1951-W.

Crude Oil Metering Specialists

ROLO MANUFACTURING COMPANY

2510 South Blvd., Houston 6, Texas
BRANCHES: Corpus Christi, Midland, Kilgore, Tulsa, New Orleans, Los Angeles, Casper, Calgary (Alta.)
EXPORT OFFICE: R. S. Stokvis & Sons, Inc., 17 Battery Place, New York, N. Y.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Anderson and Powers are Advanced To Whitney Chain Vice Presidency

J. W. Anderson

C. R. Powers

Whitney Chain Company, Hartford, Conn., has elected James W. Anderson as vice president—sales, and C. Robert Powers as vice president—manufacturing.

Anderson joined the company in January, 1938, after ten years of diversified activity in the power transmission industry. Following his first assignment in the company's Chicago branch, he was given the responsibility of developing the distribution of Whitney products in the southwestern and western states, with headquarters in Dallas. He was appointed general sales manager of the company in 1948.

Powers was formerly consultant to the president on all phases of Whitney manufacturing activities. Prior to joining the organization, he was with the Dearborn Motor Corporation, Detroit, as divisional head in charge of production and engineering research and development. He had previously been with United Shoe Machinery Company, Boston, and with Brown & Sharpe, Providence, R. I.

W-K-M Company Transfers Gallman To Houston as Sales Representative

V. C. Gallman

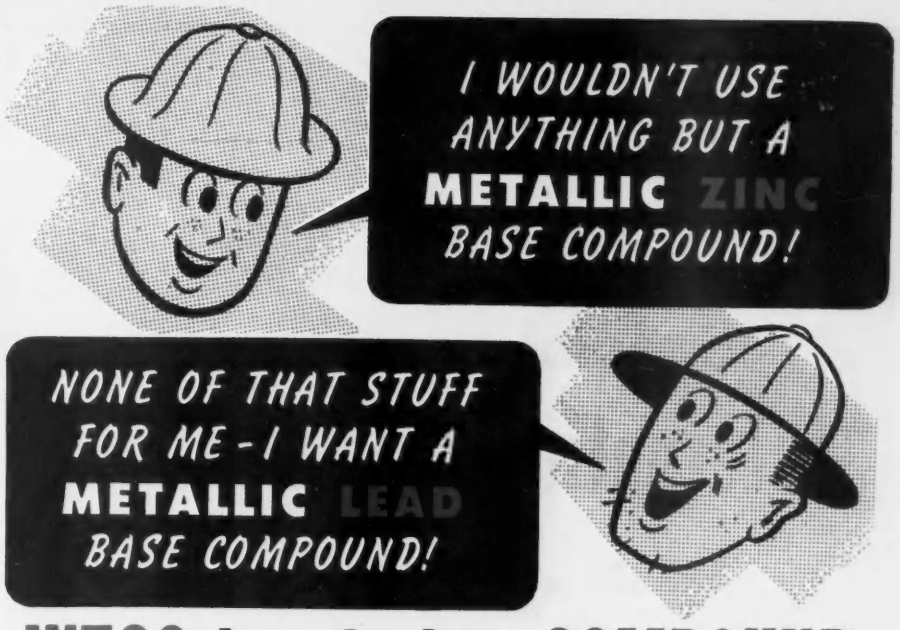
V. C. Gallman, former district representative in Tulsa for W-K-M Company, has been transferred to the company's headquarters office in Houston as general sales representative. In addition to representation in Houston, Gallman will work on pipe line sales of W-K-M Company equipment in the Central U. S. district.

Mid-Continent Opens Brownfield Store to Serve West Texas Areas

Mid-Continent Supply Company has opened a new field store at Brownfield, Texas, and has appointed A. A. Pike, former store manager at the Fullerton, Texas, store, as Brownfield store manager.

Other personnel for the new store includes L. E. Baker as field salesman; B. C. Flores, from the Odessa, Texas, store; M. H. Hughes, Jr., of the Sundown, Texas, store; M. B. Harlan, Jr. and L. O. Lilly from the Fullerton store and Robert Schmidt as warehousemen.

Operating under the Mid-Continent West Texas-New Mexico division, the new store will be under the supervision of division manager T. P. Tarwater with W. W. Arnold as district manager. The store is one mile south of town on Highway 62.



WECO has the best COMPOUND FOR BOTH OF YOU!

If you prefer a zinc base compound, you'll want NO-GALL, containing more than 50% PURE METALLIC ZINC, which exceeds tool joint manufacturers' specifications for this type of compound. It will give you maximum performance from your tool joints . . . will protect them against galling, freezing and thread friction. NO-GALL has no harmful fillers of any kind . . . will not squeeze out . . . will not harden . . . requires no thinner.

WECO STEEL-AID is what you need when you want a metallic lead base compound. It contains 67% PURE METALLIC LEAD . . . an even higher percentage than specified by tool joint manufacturers. Steel-Aid has no fillers or other harmful ingredients, is non-hardening, requires no thinner . . . will not squeeze out under extremely high torque or pressure . . . assures expected performance efficiency from tool joints.

Everybody agrees on this about HI-SPEED SEAL

It's your best thread seal for casing, tubing, steam lines, oil and gas lines and others where leak-proof connections are essential. It seals with less torque . . . assures better make-up and faster break-out. Ask for WECO HI-SPEED SEAL . . . it requires no thinner.

WELL EQUIPMENT MFG. CORP.
Subsidiary of Chiksan Company
HOUSTON 1, TEXAS
Exclusive Sales Representative Outside Mid-Continent Area
CHIKSAN COMPANY
Brea, Calif. Chicago 3, Ill. Newark 2, N. J.
Export Sales: CHIKSAN EXPORT COMPANY, Brea, Calif. Newark 2, N. J.

WECO
Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

Announcing . . .

World Oil's Special International Operations Issue . . . July 15, 1951

The most complete and up-to-date source of information on global oil operations—covering *every* country with oil development outside the U. S.

This special International Operations Issue of WORLD OIL will bring you the *finest* and *largest* collection of oil field maps bound under one cover. There are over seventy maps in this issue, showing —in *color*—the size, shape and location of oil and gas fields, pipe line outlets and the location of each refinery.

You will receive complete drilling and production information from every oil producing country in the world. This data is presented by *individual fields* and includes such vital information as: current production levels, cumulative recovery, number of producing wells, producing depths, producing formations, number of wells completed and total footage drilled.

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Major Personnel Changes Announced By Mid-Continent Supply Company

T. P. Tarwater

P. Z. Hilliard

W. W. Arnold

R. M. Flippo

Mid-Continent Supply Company has appointed T. P. Tarwater as general division manager, with headquarters in Fort Worth. Also at Fort Worth, P. Z. (Zack) Hilliard, for the past six years district manager at New Orleans, has been promoted to management coordinator.

C. M. Fleeman

Tarwater, who has been with the company since 1936, has been manager of the West Texas-New Mexico division since January, 1948. Hilliard started with Mid-Continent at the Lake Charles, La., store in August, 1934.

R. M. Flippo, division machinery manager at Houston, has been promoted to manager of sales, Machinery division, Fort Worth.

C. M. (Mac) Fleeman, district manager in Shreveport since February, 1949, has been promoted to division manager, with headquarters in Shreveport.

W. W. (Woody) Arnold has been named acting division manager for the West Texas-New Mexico division, with headquarters in Midland, Texas. He was formerly manager of the Brownfield-Snyder-Sundown area.

J. W. Hoover has been advanced from manager, Engine division at Houston, to division machinery manager there, succeeding Flippo.

The new district manager at New Orleans is W. M. (Pete) Day, who was transferred from Natchez, Miss. A 14-year veteran of company service, G. B. (Barney) Blair, has been promoted to district manager at Shreveport, from his post as sales engineer at Denver and Tulsa.

J. W. Eastham, manager of the Mid-

Continent field store at Odessa, has been promoted to district manager of the Brownfield-Snyder-Sundown area. W. A. (Bill) Sellers, former store manager at Sundown, has been transferred and appointed manager of the Odessa store. R. E. Dunn, field salesman at Snyder, succeeds Sellers as store manager at Sundown.

R. P. (Randy) Brown, field salesman at Magnolia, Ark., has been promoted to store manager there. Brown replaces B. S. Harkrider, who was transferred to Duncan, Okla., as manager of that branch.

James L. Waltrip, formerly manager of the Machinery division Quotations department, has been advanced to Fort Worth city salesman.

Du Pont Dedicates $30 Million Lab Addition to Experimental Station

Approximately 200 academic and industrial scientists were the guests of E. I. du Pont de Nemours and Company at the dedication of Du Pont's new $30 million experimental station addition at Wilmington, Del.

In addition to laboratories, the addition contains the Lavoisier Library, which has more than 25,000 books and bound journals and receives 700 current scientific and trade journals. Nineteen buildings were constructed, including nine laboratory buildings, and ten service buildings.

Byron Jackson Appoints Manager of Advertising for All Four Divisions

Theodore R. Colville has been assigned the management of advertising and sales promotional activities for Byron Jackson Company, Los Angeles, and will be in charge of the advertising for all four divisions of the company. He has been advertising manager for the Pump division since he joined the company in June, 1948. He was previously with General Electric Company, Schenectady, N. Y.

T. R. Colville

Cinch Pipeline Succeeds Coody As Bender and Clamp Manufacturer

Cinch Pipeline Equipment, Inc., Houston, successor to Coody Bender Company, is manufacturing, selling, renting and servicing the Cinch Bender and the Cinch Hydraulic Outside Line-up Clamp. Paul Barkley, president of the new company, was vice president and general manager of Coody for more than a year prior to his purchasing all the stock of Coody Bender Company, Inc., which was dissolved in October, 1950. The new corporation was formed in January of this year. No changes have been made in shop or service personnel.

Infilco Advances L. K. Cecil

Lawrence K. Cecil, general sales manager of the company since August, 1950, has been elected vice president of Infilco Inc. He has been with the company 25 years and has served as sales engineer and district manager. Company headquarters are in Tucson, Ariz.

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SINCE 1852 McGOWAN PUMPS

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McGOWAN PUMPS are in operation in Oil Fields all over the world — backed by the reputation and integrity of a Company that has been building Pumps since 1852. McGOWAN PUMPS are unequalled for ruggedness, durability and the ability to do the job — BETTER — MORE ECONOMICALLY.

They feature AUTOMATIC PRIMING — SYNTHETIC RUBBER GASKETS AND SEALS — LARGE ACCESS PLATES. Can be furnished with electric or belt drive.

McGOWAN PUMPS are available at your Supply Co. Complete information can be furnished by writing or calling McGowan Pump Co., Central Ave., Cincinnati, Ohio.

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PLUNGER PUMPS IN YOUR OIL WELLS

Our job is to provide for you a plunger pump that will insure maximum economy in producing your oil wells. In field after field, Pacific's quality materials coupled with Pacific's precision workmanship have reduced production costs as much as fifty per cent.

This economy is made possible by:

1. Pacific's exclusive strong-tough-hard MOLOY® LINERS for long life, greater resistance to temperature-corrosion-abrasion.
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4. INTERCHANGEABILITY OF PARTS — all parts of Types RLA and RLB pumps are interchangeable.
5. TWO BUSHINGS will convert Type RLA to Type RLB, or Type RLB to Type RLA.

PACIFIC PRECISION BUILT PLUNGER PUMPS IN YOUR WELLS INSURE ECONOMICAL PRODUCTION.

▲ TYPE RLB

◀ TYPE RLA

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Export Office: Chanin Bldg., 122 E. 42nd St., New York — *Offices in all Principal Cities*

MID-CONTINENT DIVISION: 1221 E. 1st St., Tulsa, Oklahoma

DISTRIBUTED IN CANADA BY: W. A. R. McGaw, 12525—72nd St., Edmonton DW-5

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Cummins Announces Major Changes In Sales and Service Organizations

Merger of two wholly owned Cummins sales and service organizations with Cummins Diesel Sales Corporation and the appointment of a general manager was announced by Cummins Engine Company, Inc., Columbus, Ind.

W. B. Lawrence

William B. Lawrence, formerly Cummins Engine Company regional manager for the Rocky Mountain region with headquarters in Denver, has been named general manager of the sales corporation, which has headquarters at Columbus.

Subsidiaries affected by the merger are Cummins Diesel Sales Corporation of Illinois at Chicago, and Cummins Diesel Sales and Service of New York, Inc., at New York City. These two organizations are now identified with Cummins Diesel Sales Corporation, which also includes Cummins dealerships with operating headquarters at St. Paul, Omaha, Indianapolis, and Memphis.

In the factory service organization, Charles C. Sons has been appointed acting eastern service manager, with headquarters in Columbus. Dillard B. Davis, formerly eastern service manager, now is regional service representative in the Central region, with headquarters in Chicago. Davis replaces Lloyd Kerber who resigned to accept the position of general service manager for Cummins Diesel Sales Corporation of Missouri, at St. Louis.

Petroleum Specialty Names Niemeier To Rocky-Mountain-Canada Position

Fred Niemeier

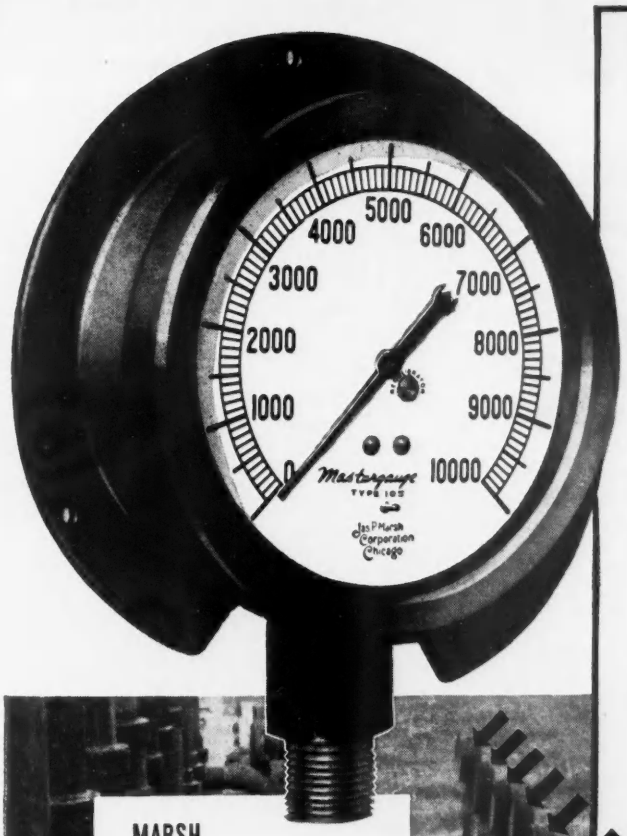
Fred Niemeier has been appointed Rocky Mountain division and Western Canada sales manager for Petroleum Specialty Company. Niemeier, whose new headquarters are in Casper, Wyo., joined the company in 1948 as sales representative for the Panhandle of Texas area, and has since worked in Oklahoma, Kansas and Illinois.

Continental Supply Transfers Two

James E. Keffer, former store manager at McCamey, Texas, for Continental Supply Company, has been transferred to San Angelo, Texas, in the same capacity. Alvin L. Rice, former floorman at Odessa, Texas, replaces Keffer at McCamey.

Pieter Smit Heads Diamond Firm

Pieter Smit has been elected president of J. K. Smit & Sons, Inc., Murray Hill, N. J., manufacturer of industrial diamond products. Smith, who until recently was secretary-treasurer, is the third generation of his family in the concern. Johan J. Smit, Sr., continues as board chairman.



It begins where other gauges leave off-

The now recognized ability of the Marsh Mastergauge to do a better job for more years is a direct result of setting out to design and build an instrument possessing accuracy, precision, and stamina beyond any gauge that had ever been produced.

Try the Mastergauge where other gauges have failed — under the gruelling conditions of extreme temperature, heavy pulsation, racking vibration — conditions that wreck the ordinary kind. You will find that it truly begins where others leave off.

We can say this today without fear of contradiction because Mastergauge has *said it for itself* . . . in thousands of applications throughout the oil country.

And remember: The toughest gauge to knock *out* of adjustment is the easiest gauge to get back *in* adjustment . . . thanks to the exclusive "Marsh Recalibrator."

Ask your supply store, or write us, for Marsh Oil Industry Bulletin.

MARSH INSTRUMENT COMPANY
Sales affiliate of Jas. P. Marsh Corporation

Dept. K, Skokie, Ill.

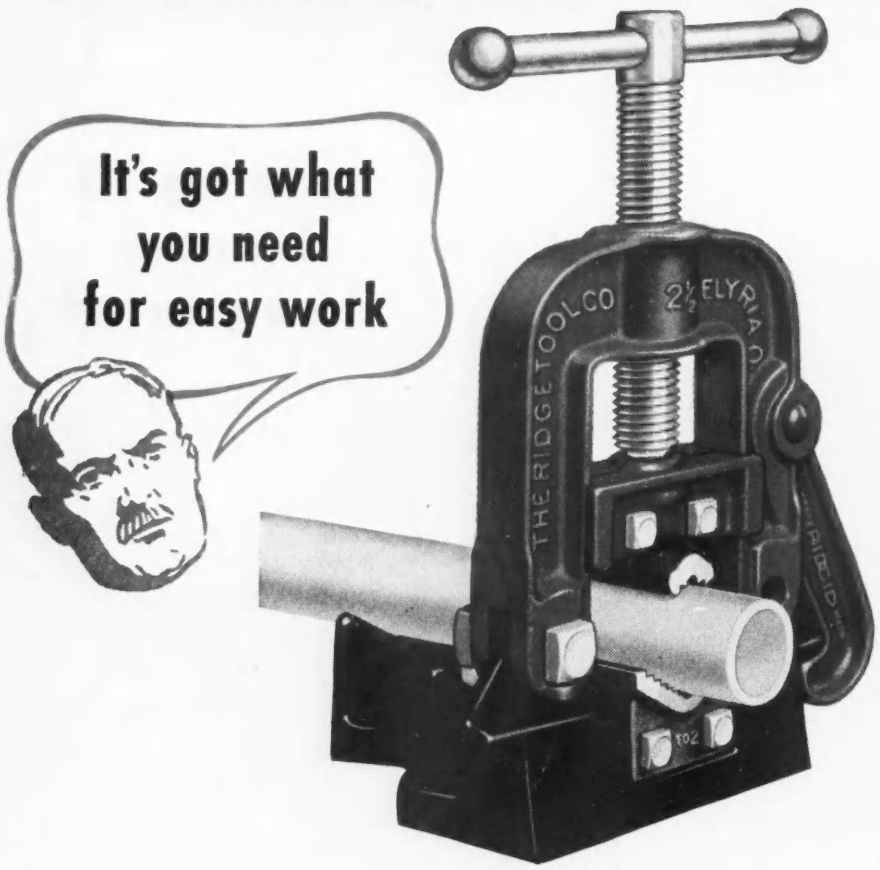
The Marsh branch plant at Houston offers shipment from stock and advanced facilities for repairing all makes of gauges.

MARSH MASTERGAUGE —

Marsh Mastergauge, guaranteed accurate within ½ of 1% of reading—a precision gauge for a precision industry. The Mastergauge line also includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers and other applications. A typical installation is this even dozen of Mastergauges in distillate fields, Cranfield, Miss.

MARSH GAUGES

The Handy Durable RIDGID Bench Yoke Vise



● You save time and effort with this more-for-your-money RIDGID Bench Vise. Right where you need 'em are its intregral pipe rest and benders that won't flatten pipe—and heat-treated tool-steel LonGrip jaws mean you don't have to be so fussy with polished pipe. Special malleable frame, extra durable. 8 sizes to 6″ pipe, bench, post, stand and Tristand models, yoke and chain. Order from your Supply House.

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★ Work-Saver Pipe Tools ★

THE RIDGE TOOL CO. • ELYRIA, OHIO

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Centrifugal Pump Consultant Named By Wilson-Snyder Manufacturing

Edward W. Johnson, formerly manager of the centrifugal pump department of National Transit Pump and Machine Company, Oil City, Penn., has been named consultant on centrifugal pumps at Wilson-Snyder Manufacturing division of Oil Well Supply Company at Braddock, Penn.

E. W. Johnson

While with National Transit Johnson designed that company's Types E-S and C-S centrifugal pumps, ranging in sizes from 1 x 1½ x 6 inches to 6 x 8 x 10½ inches. This additional line of pumps was acquired by Wilson-Snyder early this year as the National Transit properties were being liquidated.

Black, Sivalls & Bryson Announces Changes in Field Sales Organization

H. A. (Andy) Shaw, formerly manager of the Black, Sivalls & Bryson, Inc., sub-branch at Carmi, Ill., has been promoted to manager of the Oklahoma City branch succeeding C. W. (Jeff) Thomas, resigned. He is succeeded at Carmi by Gene W. Beery, who has been stationed at Odessa, Texas, as a sales and service man.

Lloyd M. Petrie, Jr., who recently joined BS&B's engineering staff as chemical engineer, has been transferred to Odessa, to replace Beery.

B. W. Bourne, field salesman at Midland, Texas, has been transferred to the Tulsa office as city sales engineer, and has been replaced at Midland by Rex A. Vicars, who was previously at Hobbs, N. M., as sales engineer. R. B. Francis Mallett, who recently joined BS&B, will be stationed at Hobbs as sales and service representative.

Walter L. Slay has been transferred from Shreveport to Magnolia, Ark., where he will have charge of a sub-branch. He succeeds Ray D. Canada, who has been assigned to the branch at Snyder, Texas, as a field salesman. Charles L. Little, Jr., has joined the company as sales engineer at Shreveport.

Norman Korn, sales engineer formerly at Casper, Wyo., has been transferred to the branch at Sidney, Neb., in the same capacity. Paul V. Hays, who has been a salesman at Blackwell, Okla., has been promoted to assistant branch manager and transferred to Casper. James W. Forney has joined the company as a field sales and service man at Blackwell.

Another Wyoming assignment involves Edwin A. Rhodes, who has been made manager of the branch at Powell, Wyo. He was formerly sales engineer at Snyder.

McCullough Opens Sterling Branch

McCullough Tool Company has established a new service branch in Sterling, Colo., at 210 North Second Street, to serve operators in the Denver-Julesburg Basin. R. E. (Rusty) Hurst, formerly in the district office at Casper, has been appointed branch manager. The Rocky Mountain district office will remain in Casper Wyo.

New Books, Maps and Movies

Basic Petroleum Geology

Fundamental bases of geologic study are covered in "Petroleum Geology," a 450-page book by E. N. Tiratsoo, English consultant. Both the academic questions related to the origin, migration and accumulation of petroleum in the subsurface, and the practical problems of discovering and exploiting oil deposits are discussed. The author treats of surface and subsurface geological and geophysical methods of exploration.

Structural and stratigraphic history of the world's oil fields is presented, with appropriate maps and geologic cross-sections illustrating the text.

Methuen & Company, Ltd., 36 Essex Street, London, W. C. 2, England. $6.

Oil in Preparedness

"On Our Toes," a slide-motion film, explains the oil industry's current position and points out why it will be capable of meeting military and civilian defense requirements promptly—if circumstances do not restrict the basic freedom of oil companies to adjust operations according to demand. In addition to its reassurances of increased quantity, the film points to the benefits resulting from the competitive struggle among oil companies to produce and maket better products.

The 16-millimeter film is black and white, and runs 13½ minutes.

Oil Industry Information Committee, 50 West 50th Street, New York, or district offices in Boston, Philadelphia, Atlanta, Cincinnati, Chicago, Kansas City, Minneapolis, Dallas, New Orleans, Tulsa, Denver. $25.

20th Century Statistics

"Twentieth Century Petroleum Statistics" is a compilation of data on all divisions of the industry, from exploration to marketing. Sources for the material include government agencies, the API and leading oil magazines. The current issue is the seventh annual edition.

DeGolyer and MacNaughton, Continental Building, Dallas. $7.50.

WORLD OIL'S Trading Post

CLASSIFIED ADS — SERVICES · PERSONNEL · USED EQUIPMENT

RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. **All classified ads payable in advance.** 10% Discount if 3 or more insertions are ordered at one time. **COPY DEADLINE:** 5th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

SITUATION WANTED

Drilling contractor operating in West Texas and New Mexico desires to contact small or medium-sized independen oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box 94-W, WORLD OIL, Houston 1, Texas.

■ CIVIL Engineer-Constructor. 38 years in Latin American Tropics. Non-graduate. Responsible charge of exploration, topographical and boundary surveys, heavy and light building and oil field construction, location and construction of railways and roads. Pensioned by major oil company after thirteen years service. Box 15-W, c/o World Oil, Houston, Texas.

■ SEISMOLOGIST, familiar with West, East and North Texas, also Gulf Coast and California offshore operations. Drilling and Production experience. Personnel Experience. Degree in Petroleum Engineering. Desires position with either major oil company or independent. Thirty day availability. Box 16-W, c/o World Oil, Houston, Texas.

HELP WANTED

MECHANICAL PETROLEUM ENGINEER

Five or more years experience for design or oil field equipment.

Union Tank and Supply Company
P. O. Box 2092
Houston 1, Texas

■ Sales Engineer. Graduate mechanical or petroleum engineering. Preferably with drilling or production experience. Write Box 18-W, World Oil, Houston, Texas.

WANTED TO BUY

■ WE WILL BUY Producing Oil Royalties. Send Particulars. Standard Security Co., 115 Broadway, New York 6, New York.

FOR SALE

Houston, Texas
Industrial-Business Property

South Main Street and Holmes Road, 5.24 acres. Fronts 1589 feet on South Main St. Pavement around entire tract. Rail Trackage available. 2 Buildings, frame, one year old. One building 70′ x 90′, other 30′ x 40′. First time this property offered for sale. Price $140,000. Land alone worth the price. Best buy in Houston. Contact owner direct: Harry S. Mitchell, 2313 Wroxton Road, Houston, Texas, Telephone JUstin 3277.

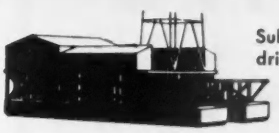
■ Well drills, spudders, rotaries, core-drills. All sizes new and used equipment. Tools, drill pipe, cable, pipe. Fishing tools rented. Everything for well drilling. Pressey & Son, Pueblo, Colorado.

■ FOR SALE: Used Askania Magnetometers. % Magnetometer Repair Department. Robertson Instrument Company, 5022 Ennis Street, Houston, Texas, JA-5813.

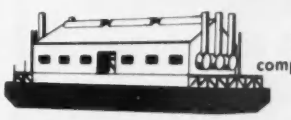
■ 15 ACRES on paved Claremont Road adjoining city limits Snyder, Texas. Suitable for oil field supply or camp site. Write Box 261, Snyder, Texas.

Levingston

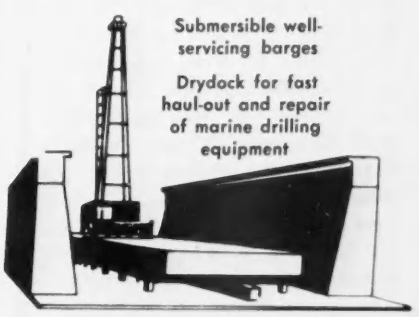
BUILDS FINE SPECIALIZED MARINE EQUIPMENT FOR THE PETROLEUM INDUSTRY


Submersible drill barges

Tugs


Boiler and compressor barges

Water, oil, and supply barges


Submersible well-servicing barges

Drydock for fast haul-out and repair of marine drilling equipment

Levingston is not only located conveniently with respect to marine drilling operations on the Gulf Coast, but here you will find marine engineers and constructors who understand the language of oil operators. Bring your marine petroleum equipment problems to Levingston *first* for a quick economical solution.

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NO-CHIP!
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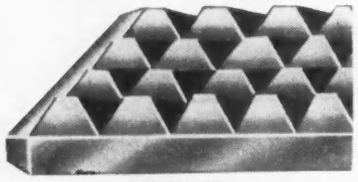
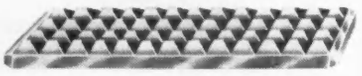
DIES

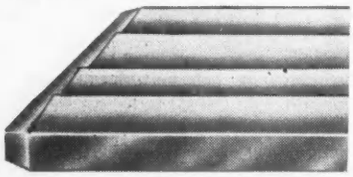


CROSS CUT



"The DIES with the GREEN ENDS"

Demco no-chip tong dies are manufactured to exacting standards from uniform high quality steel and are available in standard lengths for both 1" and 1¼" die slots. The patented chip proof ends eliminate all danger of flying bits of metal from the die while being driven into the slot, thus preventing accidents and injuries. Safety minded operators everywhere have acclaimed this startling development as pointing the way to lower costs of operation through cheaper insurance rates. Reversible, for longer wear and more convenient installation, and available in two types—regular straight tooth and pyramid (cross-cut).



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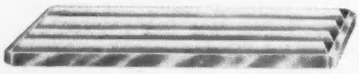
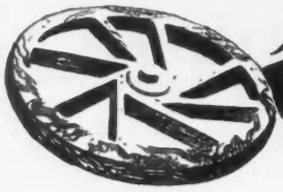


Sold Thru Supply Stores

DRILLING EQUIPMENT MFG. CO.
OKLAHOMA CITY, OKLAHOMA
PHONE 6-1342 845 S.E. 29th St. Box 4272



SQUEAKS from the BULLWHEEL

Audience Reaction

A certain person very highly placed had a seat in the gallery at Washington the day General MacArthur made his famous address.

When that person returned home, another asked: "What happened? What impression did General MacArthur make?"

The answer was a classic. It was: "There wasn't a dry eye on the Republican side or a dry seat on the Democratic side!"

Pension Plan

"Can you help me select a gift for a wealthy old aunt who is awfully weak and can hardly walk?"

"How about some floor wax?"

Party Liner

A truck driver was taking a civil service examination. He was asked this question:

"Did you ever belong to an organization that is trying to overthrow the government in Washington?"

"Yes."

"What? You did! What is that organization?"

"The Republican Party!"

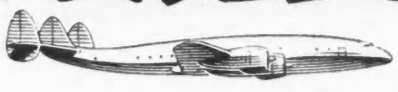
"What'd I tell you about bringing your wife along on the job?"

Purpose

"Daddy, why do the ladies always bring their knitting when they come to the house?"

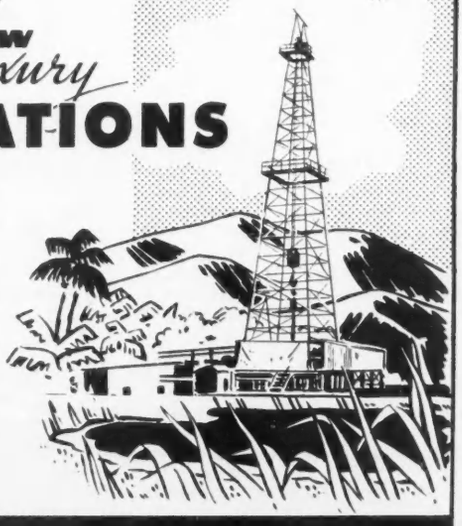
"It gives them something to think about while they're talking."

FASTEST SERVICE TO
VENEZUELA



C&S NEW luxury
CONSTELLATIONS

Flights each way every day aboard C & S New Luxury Constellations through the New Orleans gateway offer 300-m.p.h., pressurized cabin service to the oil fields of Venezuela. One carrier service from Houston, St. Louis, Chicago and Detroit, with connections at New Orleans to and from Dallas, Tulsa, Los Angeles and San Francisco. For reservations call the nearest C & S ticket office or your Travel Agent.



CHICAGO & SOUTHERN AIR LINES
GENERAL OFFICES • MEMPHIS 2, TENN.

What's NEW

In Perforating, Testing, and Fishing Tool Services

McCULLOUGH®
NEW SERVICES • NEW TOOLS
NEW WAYS OF DOING THINGS

Latest News About New Tools, Techniques and Services

Why McCullough Customers Specify
BURRLESS BULLETS
Burr-Free Holes Are Only Part of the Reason

In gun perforating many factors affect the penetrating ability of a bullet. The shape of the bullet is one of the most important factors.

Conical shaped armor piercing bullets obtain the deepest penetration. However, a conical shaped bullet has two disadvantages:

1. **A conical bullet leaves a large, jagged burr on the inside of the casing.**
2. **A conical bullet has a tendency to skid.**

In the beginning, conical shaped bullets were used almost exclusively in all gun perforators. In an attempt to minimize the burr, the ogival (an arc coming to a point) bullet was developed. Today, this type of bullet is used in most gun perforators. However, there are three disadvantages in using an ogival shaped bullet:

1. **It still leaves a large burr, although the jagged edges are bent over. Due to this burr a casing scrapper must be used before running close fitting tools, such as: packers, testers, bridging plugs, swabs, etc., to prevent damage to these tools.**
2. **The bullet still has a tendency to skid.**
3. **The shape of the bullet tends to diminish penetration.**

Development of the Burrless Bullet

Several years ago an attempt was made by several service companies to develop a burrless bullet. Although burrless bullets were developed, the diminishment in penetration was so great that they were valueless.

The McCullough Tool Company, however, continued its research. A true burrless bullet was developed that not only eliminated the burr but actually increased penetration. These burrless bullets have been standard equipment on all McCullough Gun Perforating jobs for several years.

Advantages of the McCullough Burrless Bullet are:

1. **No burr is left on the inside of the casing, eliminating the need of casing scrapers after the perforating job.**
2. **Increased penetration.**
3. **Cannot skid.**

The burr and tendency to skid is completely eliminated by the addition of an ogival shaped alloy jacket on the bullet itself. Shape of the bullet under the jacket is conical. When fired, the alloy jacket is consumed in the first string. Thereafter, the deepest penetrating bullet known — the conical bullet — penetrates additional strings, the cement sheath, and deeper into the formation.

Can Only Be Used In McCullough Gun Perforator

Due to the design of the McCullough Gun Perforator, it is the only gun that can use this type of bullet. The seal in the McCullough Gun Perforator is behind the bullet, in other guns—in front of the bullet. Therefore, if used in other types of gun perforators, the alloy jacket would be lost while leaving the gun body. Most sizes of McCullough Gun Perforators use all five sizes of burrless bullets—¼", ⅜", ½", ⅝", and ¾". Special sizes are also available to meet specific needs.

When ordering gun perforating service, customers invariably specify burrless bullets, although they know we also have standard ogival bullets available.

Write for this Catalog

The new McCullough section of the Composite Catalog is now ready. Pages 3205 to 3244 are devoted to the McCullough Gun Perforator. Page 3217 describes the Burrless Bullet and a 7,188 hole perforating job completed in only 65 hours. Write to the McCullough Tool Company for your copy.

PERFORATING, TESTING AND FISHING SERVICE ANYWHERE — ANYTIME!

McCULLOUGH TOOL COMPANY
5820 South Alameda Street, Los Angeles 58, California
405 McCarty Street (P.O. Box 2575) • Houston, Texas
CANADA: Edmonton, Alberta • EXPORT OFFICE: Los Angeles, California
VENEZUELA: United Oilwell Service Co., S.A.; Caracas, Anaco, Maracaibo

SERVICE LOCATIONS:
TEXAS: Houston, Snyder, Alice, Cisco, Corpus Christi, McAllen, Odessa, Tyler, San Angelo, Victoria, Wichita Falls. **OKLAHOMA:** Oklahoma City, Guyman, Healdton. **MISSISSIPPI:** Laurel. **NEW MEXICO:** Hobbs. **KANSAS:** Great Bend. **WYOMING:** Casper. **CALIFORNIA:** Los Angeles, Avenal, Bakersfield, Ventura. **LOUISIANA:** Houma, Lake Charles, New Iberia, Shreveport.

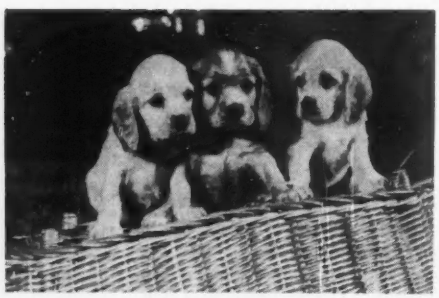
Mid-Continent NEWS and HUMOR?

. . . and Mid-Continent's field supply stores are loaded too! Loaded with the finest oilfield equipment that can be found . . . loaded with the best oilfield service that can be offered, service that is available to the industry 24 hours a day.

●

But, it isn't all work and no play in the oil business . . . it, like any other industry, has its lighter side . . . and we at Mid-Continent have our lighter side too . . . even though—

Some of Our Humor Bewilders PEOPLE *Too!*



MID-CONTINENT Supply Company

General Offices Mid-Continent Bldg. FORT WORTH, TEXAS

SQUEAKS FROM THE BULLWHEEL

Credit or Blame?

"Indeed, yes, I am a self-made man."

"Sir, you have relieved the Lord of a great responsibility."

Nearly Paradise

In defending his state the Arizona native was saying, "All we need is a better type of settler and more water."

"When you come to think of it," retorted the tourist, "that's all that Hell needs."

The Curse of Habit

The banker who had gone to a doctor for a physical checkup was told to get out into the open air, so he quit his job at the bank after 35 years and bought a filling station.

The first morning he was open for business a man drove in and asked for ten gallons of gasoline.

"Where are you going?" asked the former banker.

"To Tulsa and back," was the answer.

The banker looked at him sternly and said, "Don't you think you can get along on five gallons?"

Mother of Invention

Wife: "How helpless you men are! What would you do if there were no women to sew on your buttons for you?"

Husband: "Has it occurred to you, my dear, that if there were no women that we men would need no buttons?"

Standards

Texas leads in everything, as any of its inhabitants will admit, and the latest source of pride to dyed-in-the-wool Texas boosters is the unique method devised by a Texas farmer for weighing his champion hogs. Seems the hogs are too big to be weighed by ordinary scales. So the farmer places a log across the top of a fence, puts a hog on one end, and piles rocks on the other, until they just balance. Then the farmer guesses the weight of the rocks.

The Best Teacher

"My boy," said the successful man lecturing his son on the importance of thrift, "when I was your age I carried water for a gang of bricklayers."

"I'm proud of you, father," answered the boy. "If it hadn't been for your pluck and perseverence, I might have had to do something of that sort myself."

All Things to All People

Mouth: The grocer's friend, the orator's pride, the fool's trap and the dentist's salvation.

Mutual Problem

An old man walking down the street noticed a small boy sitting on the curb, crying. "Little boy, why are you crying?" asked the old fellow.

"Because I can't do what the big boys can do," replied the small boy between sobs.

So the old man sat down and cried with him.

Revolution

"Has your wife changed very much since you married her?"

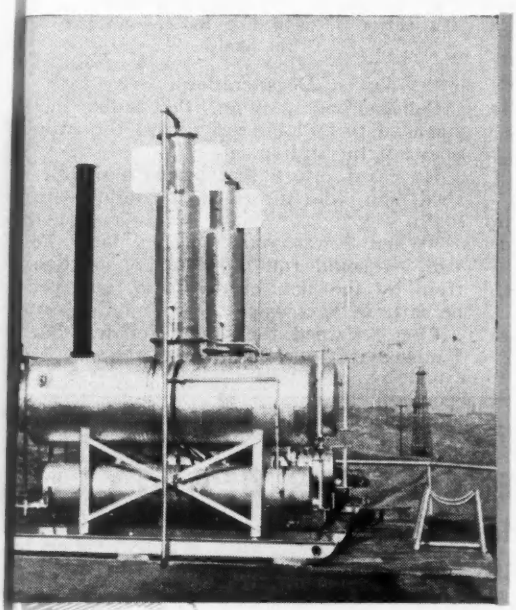
"I'll say—my habits, my friends and my hours."

Acme

The world's best after-dinner speech: "Waiter, give me both checks."

THAT REMINDS ME - THESE NEW LANE-WELLS SLIPS ARE THE SLICKEST THINGS YET - SLIDE UP AND DOWN SO EASY - AND NEVER BIND!
BUS STOP
CP-401

DOLLAR-WISE DEHYDRATION!



● The problem...*too many freeze-ups, too much down-time, not enough production!*

The solution...dollar-wise BS&B Dehydration. Here's what it will do for you:

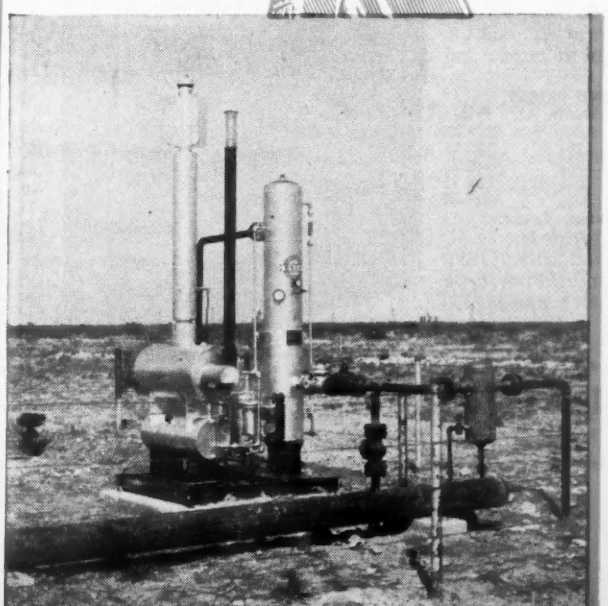
1. It will *definitely dehydrate* your gas. Gas leaving the unit is free from water "slugs".

2. It will save you money by eliminating "freeze-ups" and "shut-down time".

BS&B offers the highest guaranteed dew point depression of any glycol dehydrator designed for field installation. Smallest units give 40 to 55 degrees F.; the larger, 55 to 75 degrees F.

The high efficiency of BS&B wet-type dehydration grows out of BS&B's long experience with oil and gas handling equipment. For 58 years, BS&B has led the petroleum field in the designing and manufacturing of advanced, superior producing and processing equipment.

Learn now how BS&B Glycol Dehydration can help you make more money from your gas operations. Write today!



BLACK, SIVALLS & BRYSON, INC.

Oil and Gas Equipment Division

2131 Westwood Blvd., Rm. 5B

Oklahoma City, Oklahoma

BS&B

Glycol-Type

DEHYDRATORS

Scottie (Rugged Character) McBlock says, "A champion never lets down his guard."

TYPE RP

TRAVELING BLOCKS

ARE FULLY GUARDED for Safety

They're RUGGED, with Hi Load bearings, large diameter center pins, alloy steel flame hardened sheaves, all steel construction.

They're COMPACT . . . Short Overall Length . . . may be directly connected to most popular hooks.

They're ECONOMICAL in cost and operation.

Write for catalog of this and other McKissick Products.

McKISSICK BUILDS A BETTER BLOCK FOR EVERY PURPOSE

McKISSICK

McKISSICK PRODUCTS CORPORATION
Box 2496 Tulsa, Oklahoma

SQUEAKS FROM THE BULLWHEEL

Family Disgrace

A southern farmer was introducing his family of boys to the President.

"Seventeen boys," he said. "All are democrats but John, the little rascal. He got to readin'."

Joy Boy

"It's so good of you, doctor, to have come this far to see my husband."

"Not at all, madam, not at all. I have a patient next door, so I thought I'd just kill two birds with one stone."

As a Matter of Tact

Husband: "My dear, I believe you fib once in a while."

Spouse: "Well, I think it's a wife's duty to praise her husband occasionally."

Two-Way Stretch

Life is just an everlasting struggle to keep money coming in and teeth and hair and vital organs from coming out.

Long Range Plan

A man stopped in at a jewelry shop to look at some sale watches advertised at a below cost price.

"If you're selling these at less than cost, how do you make any profit?" he asked.

"Oh," replied the jeweler, "we make our profit repairing them."

"It's cuttin' through like butter—never seen the like!"

Degeneration

Puffing and panting, the sailor just managed to pull himself aboard the train as it left the station.

He eased into a seat beside a middle-aged man, who turned to the sailor with scorn.

"When I was your age, my lad," he said, "I could run a half mile, catch a train by the skin of my teeth, and yet be as fresh as a daisy."

"Yes," gasped the young fellow, "but I missed this one at the last station."

Prompt Attention Given to Foreign Orders

"THE LUSTROUS SEVEN STAR BEAUTY"

World's Best Map Filing Cabinet

CONVENIENT • INSTANT REFERENCE • SPACE SAVER • INSTANT FILING
DUST PROOF • RUST PROOF • MEDDLER PROOF

Ultra Attractive fits the furniture scheme of any office.

Instant Adjustment—for maps or tracings from 12" to 54" long. Each Well 2" x 2", equipped with individual wood slide with holes on 2" centers, through which one screw when matched to hole in adjustment block and tightened, automatically gives perfect alignment at top for all length maps.

Substantial lock—Individually keyed.

Exterior of cabinet made of 3/4" five ply beautiful grained hardwood mitered locked joints, banded edges on door and top. Interior partitions 3/8" thick, and 1/4" slides, all three ply veneer of southern hardwood or fir.

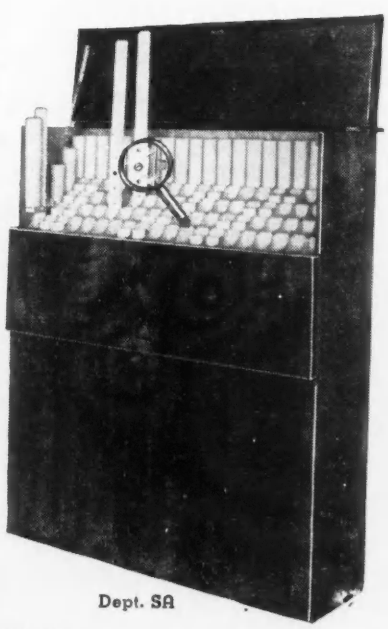
OVERALL DIMENSIONS—AND PRICES

Capacity	Width	Height	Depth	Price
60 "	29 3/8"	57"	13 3/4"	$107.25
75 "	36 3/8"	57"	13 3/4"	123.75
100 "	47 7/8"	57"	13 3/4"	140.25
160 "	47 7/8"	57"	20 1/4"	183.75
200 "	59 1/2"	57"	20 1/4"	217.25

All prices are F.O.B. Houston, Texas.
Delivery: From ten to thirty days.

Finished: Walnut, Oak, Mahogany, Olive Drab Green, Natural or Blond. Other type cabinets designed to suit your needs. Information on request.

We specialize in Drafting Boards, Light Tables and other types of cabinets, made to your specifications.



Dept. SA

PORT CITY CABINET WORKS

609-13 Quitman St. HOUSTON 9, TEXAS Phone PR-0725

Building Strength for the Free World

*Highlights from the Annual Report of Standard Oil Company (New Jersey)**

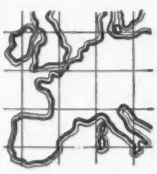
for 1950... a year of record activity

Standard Oil Company (New Jersey) is an American corporation which has, in varying degrees, investments of capital and technical knowledge in a large number of operating oil companies, both in the United States and abroad. In 1950, these companies:

IN THE U. S. A.

Drilled over a thousand new wells, with an unusually high proportion of producers . . . Improved and expanded refineries in New Jersey, Maryland, Louisiana, and Texas . . . Completed a new continuous wax-making plant at Bayonne, N. J. . . . Added 370 miles to Texas crude oil pipeline systems . . . Started doubling the capacity of a products pipeline across Pennsylvania . . . Let contracts to increase by 85% the capacity of a pipeline from Baton Rouge to the Southeastern states . . . At government request, re-activated two government-owned Butyl rubber plants; also continued operating two others which have been producing constantly since 1943 . . . Invested over 20 million dollars in laboratory research for new and improved processes and products.

IN WESTERN EUROPE



Proposed a plan which ended gasoline rationing in England . . . Went ahead of schedule in construction of a new refinery at Fawley, England, to be the largest in Europe . . . Expanded, improved or started construction of refineries in Norway, Belgium, West Germany, France, and Italy . . . Opened many new service stations, which served not only local motorists, but some 18,000 American tourists . . . Supplied 28% more fuel oil than a year ago, to meet needs for industrial expansion . . . Met the greatest demand for asphalt for new road building ever experienced in these areas.

IN THE MIDDLE EAST

Stepped up oil production substantially in Saudi Arabia . . . Opened the vitally important Trans-Arabian Pipeline system from oil fields on the Persian Gulf to the Mediterranean . . . over 1,000 miles of 30- and 31-inch pipe . . . Started construction of a large-diameter pipeline extending 550 miles from Iraq to the Mediterranean.

IN THE FAR EAST

Expanded production of crude oil in Indonesia and explored for oil in Papua . . . Increased output of refineries in Australia, Sumatra, Japan.

IN CANADA

Produced nearly 50% more oil than a year ago . . . Made new oil and gas discoveries in Ontario and Alberta . . . Operated nine refineries at 14% greater output than a year ago . . . Opened a new 1,100-mile pipeline system from Alberta to Lake Superior, to carry crude oil toward the major Canadian refineries and markets.

IN SOUTH AMERICA

Set a new production record in Venezuela, second largest oil-producing country in the world . . . Operated the big Aruba refinery in the Netherlands West Indies at a higher rate than ever before . . . Met sharply increased call for products throughout the continent, to support the vigorous post-war development.

IN OCEAN TRANSPORT

Received the last 4 of 12 super-tankers ordered two years ago . . . Ordered 6 more new tankers . . . Operated an ocean-going tanker fleet of 117 vessels, totaling over 2 million deadweight tons.

IN EMPLOYEE RELATIONS

Continued the same favorable labor relationships that have prevailed for more than three decades, with no strikes in domestic operations.

THE YEAR ENDED . . . THE JOB GOES ON. In 1950, for the first time, world use of oil outside the Iron Curtain passed 10 million barrels a day. For comparison, it was just over 7 million in 1945, the peak war year.

This is significant to free people everywhere. Oil supplies in today's world are closely linked to living standards and national strength.

It seems clear that more and more the world will look to oil to help keep it free and progressive. More and more it becomes clear, in meeting that need, that the American-developed business process of risk and result . . . of competition spurring corporate ingenuity and responsibility . . . is a strong and flexible system for promoting the welfare of people.

* We will be pleased to send a copy of the full report to anyone wishing it. Write Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

FINANCIAL SUMMARY

Standard Oil Company (New Jersey) and Consolidated Affiliates

Total income from sales, services, dividends and interest . . $3,198,266,000	Taxes collected for governments . . $294,749,000
Net income . . . $408,223,000 or $13.48 per share	Wages and other employment costs . . $548,205,000
Dividends . . . $151,028,000 or $5.00 per share	Spent for new plants and facilities . . . $295,132,000
Taxes paid . . . $276,000,000	Number of stockholder-owners 222,000
	Number of employees 116,000

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

THESE FOUR ADVANTAGES OF

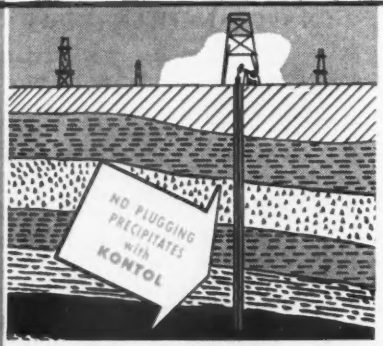
KONTOL CORROSION INHIBITOR

SAVE TROUBLE AND MONEY

1

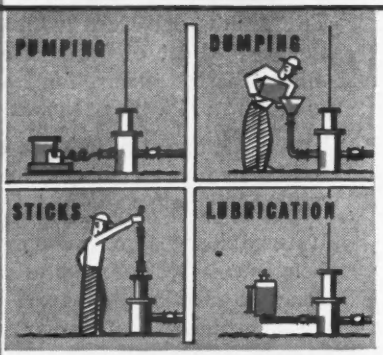
KONTOL does not complicate the treatment of oil field emulsions. Emulsions from Kontol-protected wells respond readily to routine demulsification measures.

2



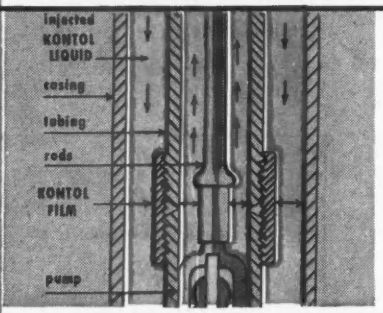
KONTOL does not form precipitates which may plug tubing, producing formation or water disposal wells. It does not raise the pH of the brine.

3



KONTOL is simple and economical to use. No elaborate mechanical devices are necessary. Kontol is easily pumped, lubricated or dumped into the well annulus.

4



KONTOL mixes with the well fluids and adsorbs to the surfaces of the pumping equipment. The Kontol film resists attack by corrosive elements, materially increasing the useful life of rods, casing, pumps and tubing.

For complete information or literature on KONTOL, ask your Tretolite Engineer or get in touch with

TRETOLITE COMPANY

Manufacturing Chemists

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

CHEMICALS FOR THE PETROLEUM INDUSTRY

Dehydrating • Desalting • Water De-oiling
Corrosion Inhibition • Scale Prevention • Paraffin Removal

ESTABLISHED 1916
as The OIL WEEKLY

WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING, PRODUCING, PIPE LINE OPERATIONS AND MANAGEMENT

Subscription Price, $2 Per Year JUNE, 1951 Price This Copy, 50 Cents

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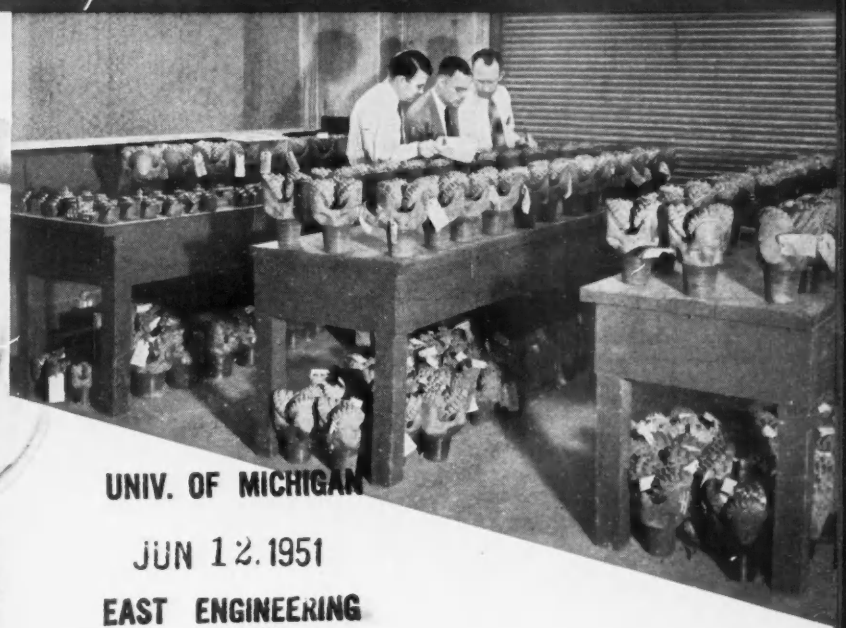


HUGHES
TRI-CONE
ROCK BITS

Hughes Rock Bits have no Private Life

Never-ending inspection is the lot of a Hughes Tri-Cone Rock Bit. At every stage in manufacture and *use* it comes under someone's close scrutiny.

Shown here is a typical example of what we mean. These engineers are inspecting worn Tri-Cone bits sent in by Hughes field engineers for research analysis and study. Selected from thousands of bits, run on thousands of rigs, they give Hughes the broadest possible information about bit performance under every type of operating condition.

The result of this constant probing by Hughes engineers is *faster hole and more hole per bit!* It accounts for the fact that Hughes Rock Bits are accepted as the standard of the industry...throughout the world.

Successful Performance

IN THOUSANDS OF WELLS—

● It takes a star to come through in the clutches, and the record shows that Oil Men rely on 'Starcor' for deep-well cementing jobs where the going is toughest. A cement has to be good to hang up a record like 'Starcor's—a record of uniformly successful performance in thousands of wells in the nation's principal oil fields ever since 1936.

'Starcor'*, one of three great Lone Star Cements—made by a quality-minded organization which carries on a continuing program of oil-well cement research—to give the Oil Man what he wants, when he wants it.

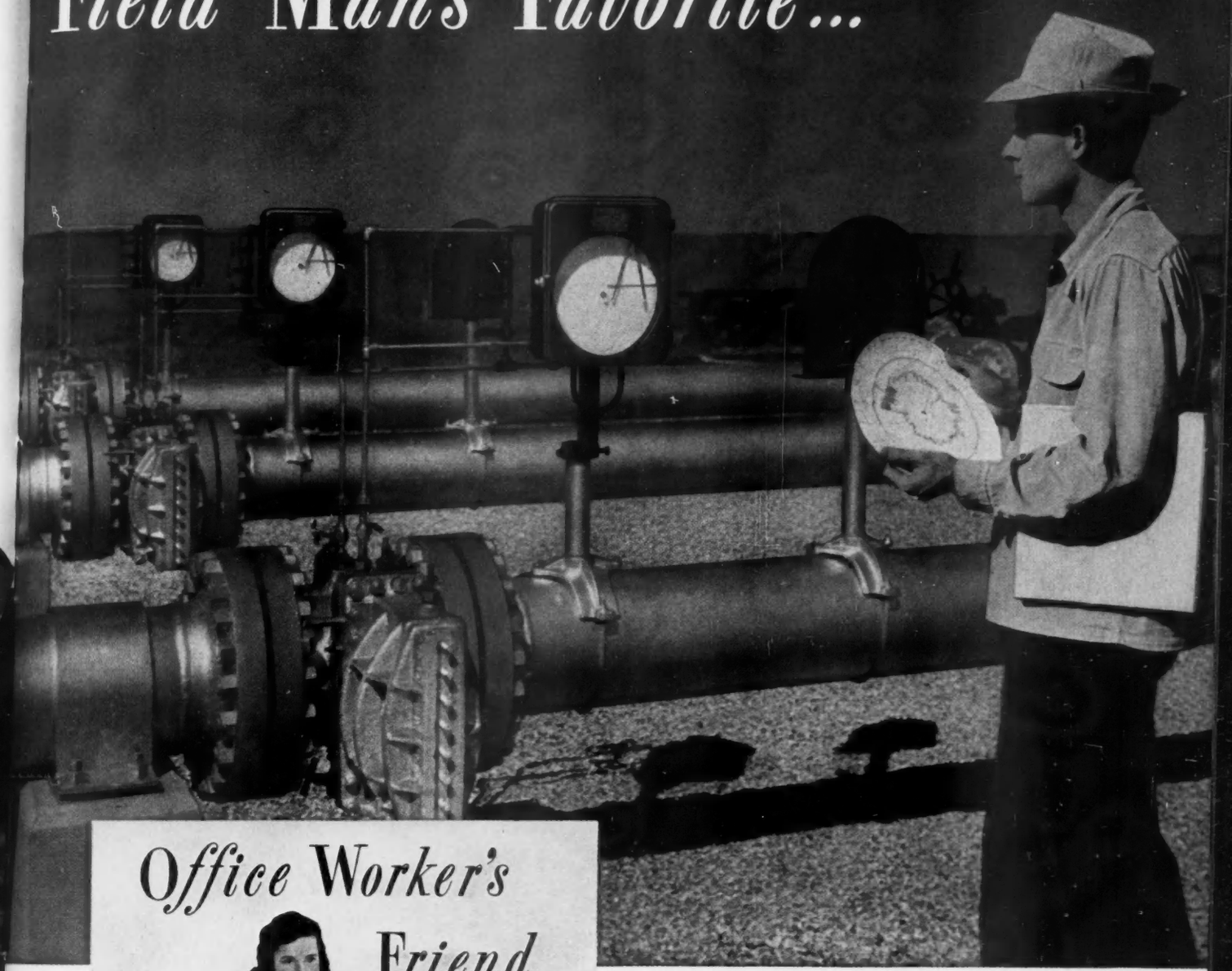
*Reg. U. S. Pat Off

SELECT CEMENT TO FIT THE JOB

LONE STAR CEMENT CORPORATION

Offices: DALLAS • HOUSTON • NEW ORLEANS • BOSTON
KANSAS CITY, MO. • BIRMINGHAM • JACKSON, MISS.
INDIANAPOLIS • ALBANY, N. Y. • BETHLEHEM, PA.
CHICAGO • NORFOLK • PHILADELPHIA • RICHMOND
ROANOKE • ST. LOUIS • WASHINGTON, D. C. • NEW YORK

Field Man's Favorite...



Office Worker's Friend

THE ROCKWELL INTEGRATOR

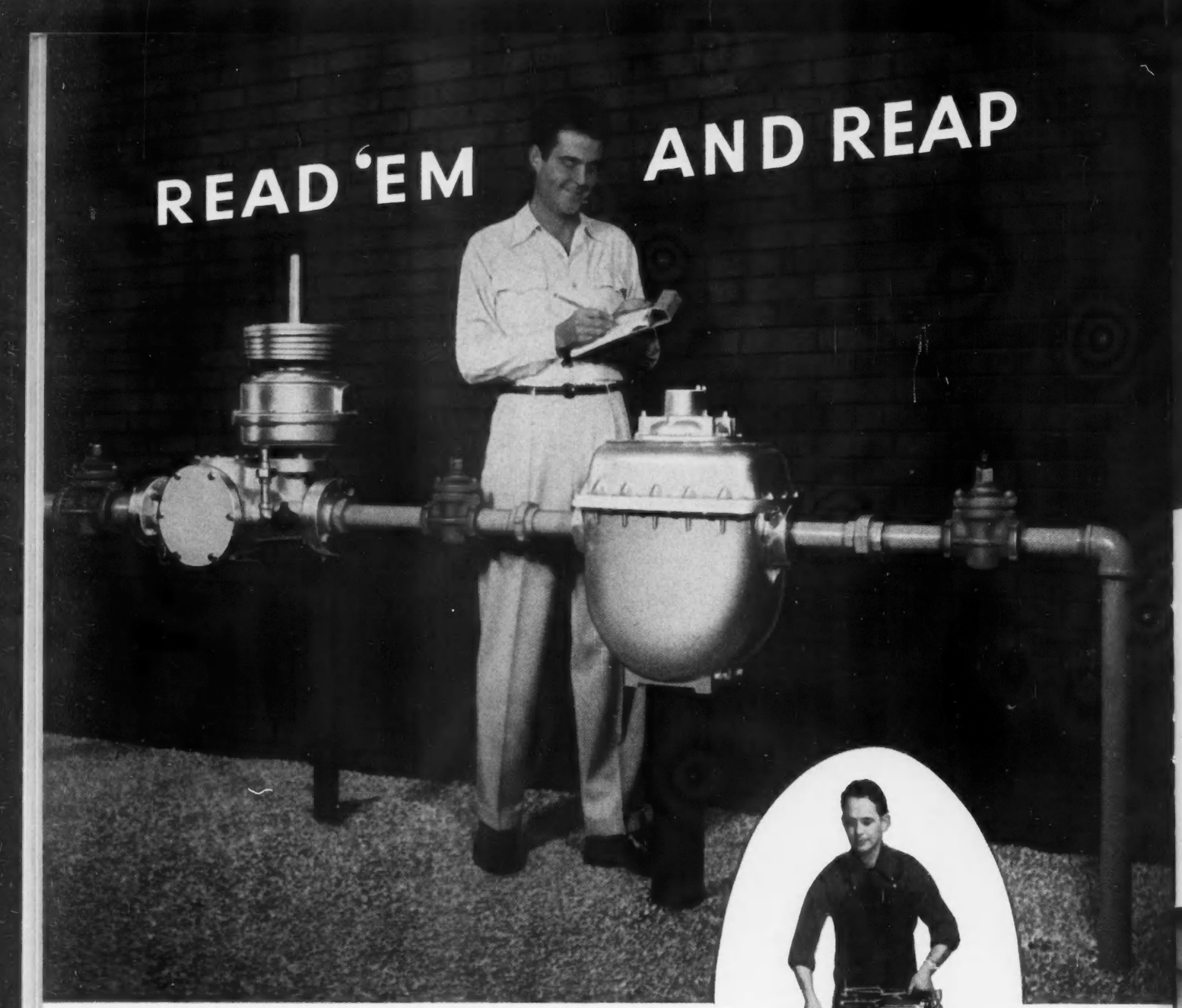
With a Rockwell integrator you can read from the counter the true values of recorded flow on various makes of simple flow meters. The integrator mechanically computes orifice meter charts—up to 300 average charts a day. Accuracy is assured since the operator traces the same recording of static and differential as was made by the gauge.

Everybody benefits where the Rockwell system of orifice metering is in use. In particular, field men appreciate the extra strong construction of Rockwell meters . . . the clean cut simplified arrangement of working parts . . . the clear, legible records left by the positive inking pens. They also like the service convenience of a meter design that can be maintained with common, everyday tools.

When you use Rockwell meters in the field and have one or more Rockwell integrators in the office you gain the benefits of machine precision in both recording and computing. You gain the *highest* degree of accuracy at the *lowest cost* per cubic foot measured.

The Rockwell System of ORIFICE METERING

READ 'EM AND REAP



Rockwell METERS

insure PRECISION ACCURACY

plus maintained economy

You'll harvest bumper crops of B. t. u's from Rockwell meter and regulator settings. That's because of in-built precision. But Rockwell equipment goes one step further. It's the most economical to maintain. No other meter has the bowl type body with its removable and interchangeable valve plate mechanism. This feature brings important savings to you in service and convenience. For complete details write for Bulletin 1003.

EASIEST TO INSPECT

EASIEST TO SERVICE

Rockwell
MANUFACTURING COMPANY
400 North Lexington Avenue, Pittsburgh 8, Pennsylvania
Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa.

Meters

TIN

ALUMINUM

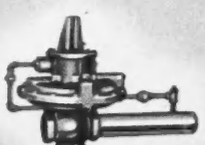
CAST IRON

PRESSED STEEL

Regulators

APPLIANCE

SERVICE


"1001"

BALANCED VALVE

There's a **ROCKWELL METER & REGULATOR** for every use

WORLD OIL

INTERNATIONAL SECTION

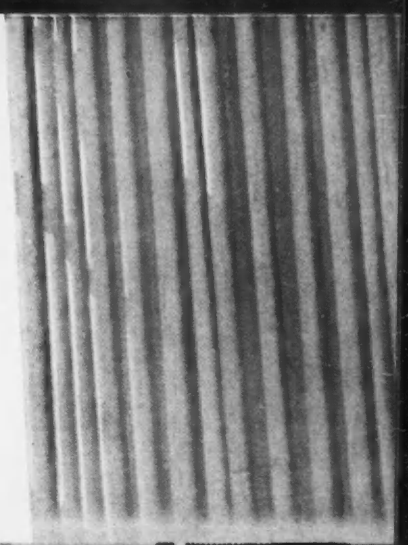
You're never in doubt with Hughes Flash-Weld Tool Joints

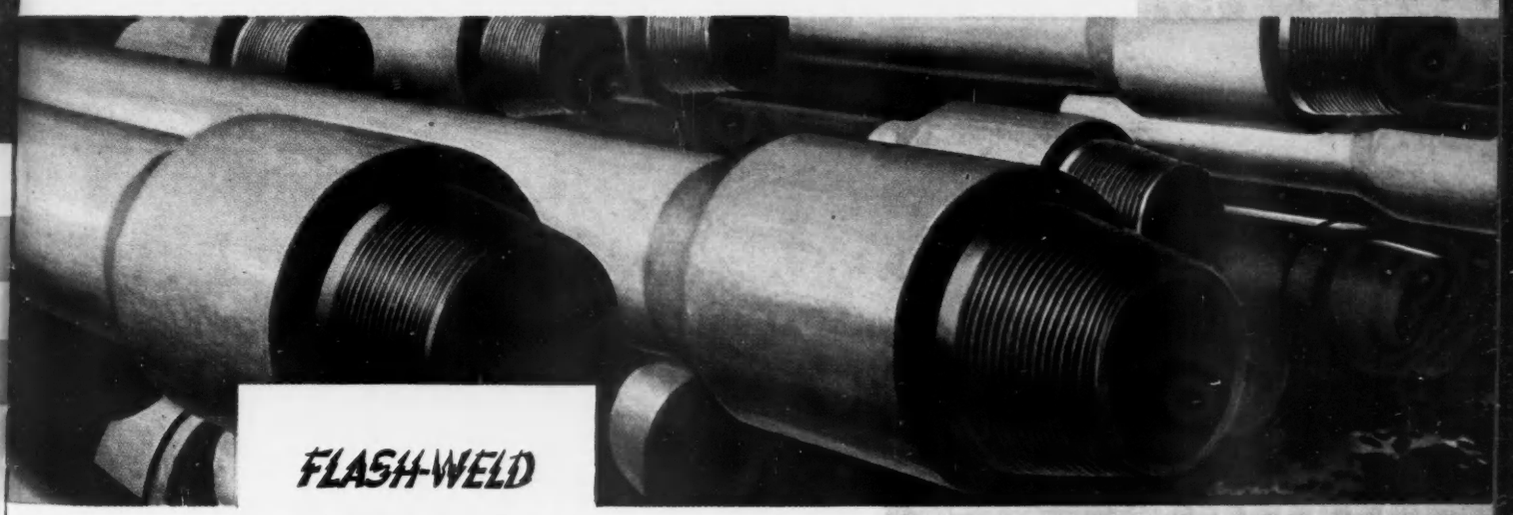
IN MILLIONS OF FEET OF HOLE, drilled in thousands of wells, Hughes Flash-Weld tool joints have set a record for unequaled dependability.

There's a very solid reason for this. Fifteen years ago, Hughes undertook the designing of a better type of drill stem. Engineers and metallurgists spent three years in full-scale research in developing the welded-type joint and the specially designed flash-welding machines now used.

Since offering them to the trade 12 years ago, more than 19,000,000 feet of drill stem have been equipped with Hughes Flash-Weld tool joints. During this period manufacturing techniques have undergone constant improvement.

There has been no known failure in the weld of a Hughes Flash-Weld tool joint processed in the past two years.





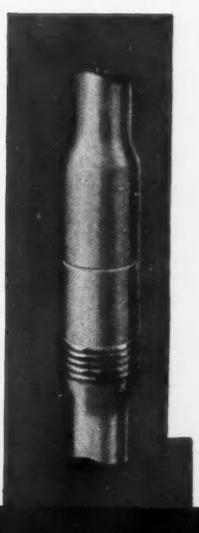
FLASH-WELD

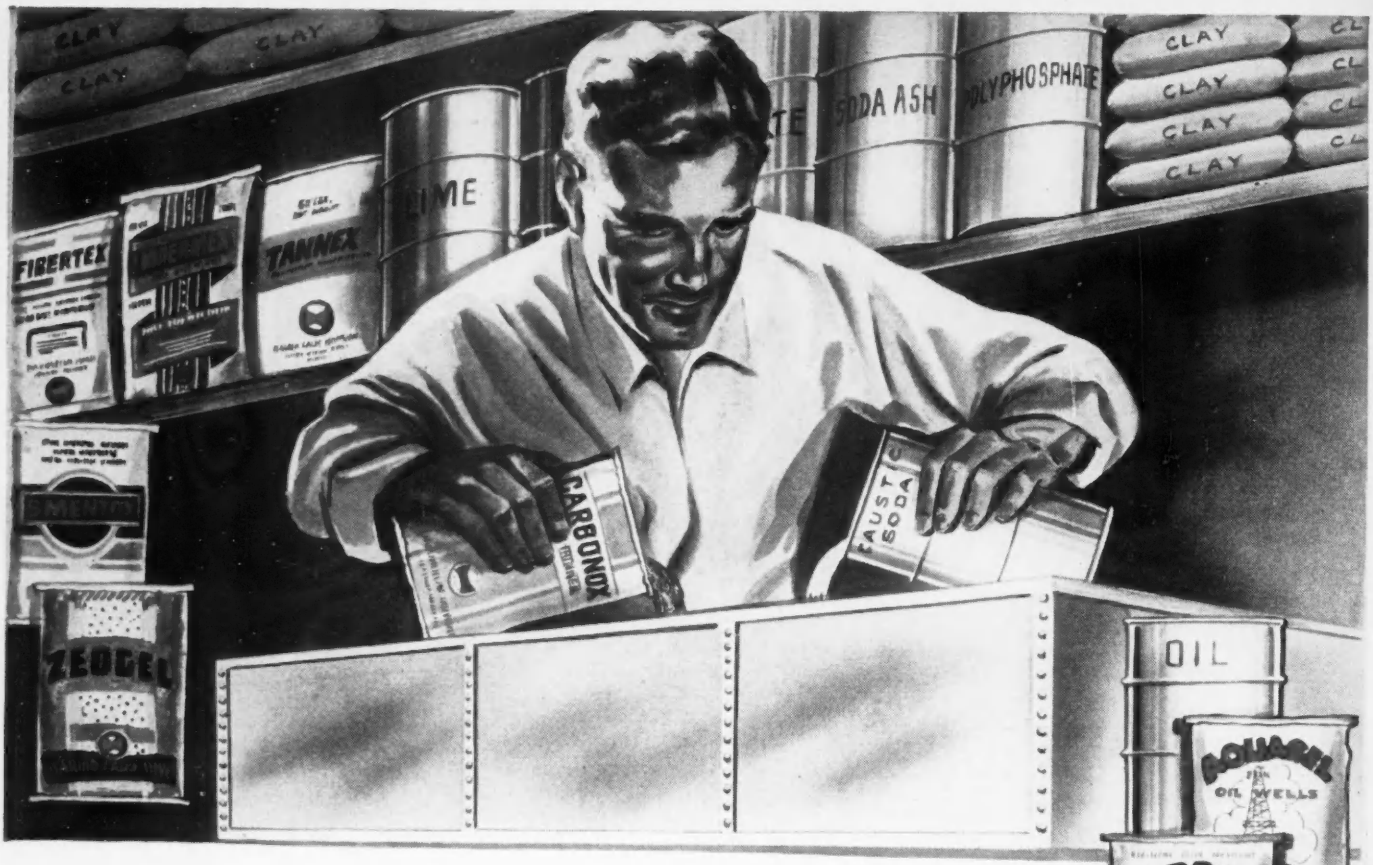
A DEVELOPMENT OF

HUGHES

TOOL COMPANY

HOUSTON, TEXAS

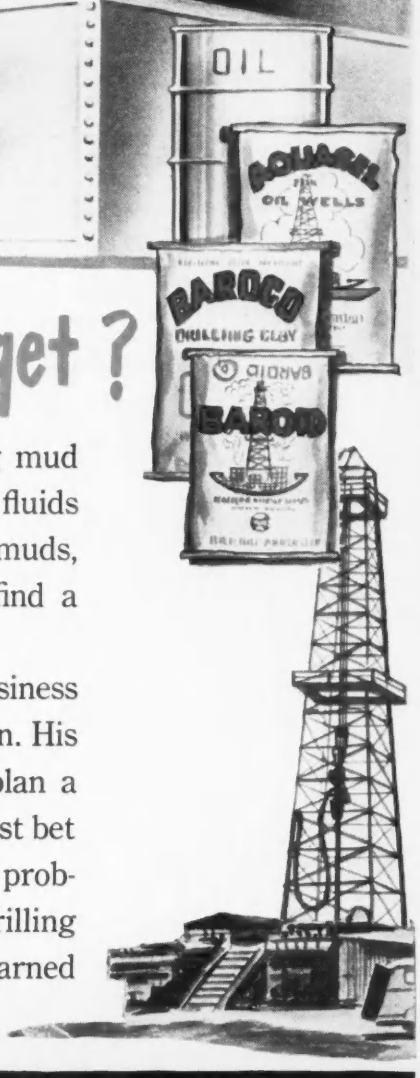




How complicated can mud get?

CLAY, WATER AND WEIGHT MATERIAL–that was your drilling mud not many years ago. But with today's drilling problems, drilling fluids now are a full-time study. High-pH muds, red muds, lime-starch muds, salt-water muds, oil-emulsion mud, organic-colloid muds–all find a place in meeting today's varied drilling problems.

BUT YOU NEEDN'T WORRY–drilling muds are the full-time business of your thoroughly trained and experienced Baroid service man. His knowledge is yours whenever you want it. He can help you plan a complete drilling fluid program even before you spud in–your best bet for economical, trouble-free operations. He can advise on specific problems as they arise. His knowledge of drilling conditions and drilling muds has helped many operators save time, trouble and hard-earned dollars. Call your Baroid man–and lighten your load!



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COMPLETE DRILLING MUD SERVICE

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IS "CRACKING" PRODUCTION RECORDS

HYDRAFRAC
SERVICE

A growing number of wells have responded with remarkable success to Howco's Hydrafrac service. There is no doubt but that well owners have available here a proved means of increasing production; with very profitable returns... Howco's Hydrafrac service is a method of hydraulically fracturing the producing formation, creating new and greater permeability within the zone being treated. This method was first used successfully in old wells to recover additional oil reserves and increase the production rate. Now it is also well established as a new completion method—and is more economical and convenient while the drilling rig is over the hole... Thorough analysis of your well by Howco will indicate whether or not Hydrafrac Service can help you crack production records. Telephone your nearest Howco representative.

"THERE'S NO SUBSTITUTE FOR EXPERIENCE IN OIL WELL CEMENTING"

HALLIBURTON OIL WELL CEMENTING CO.

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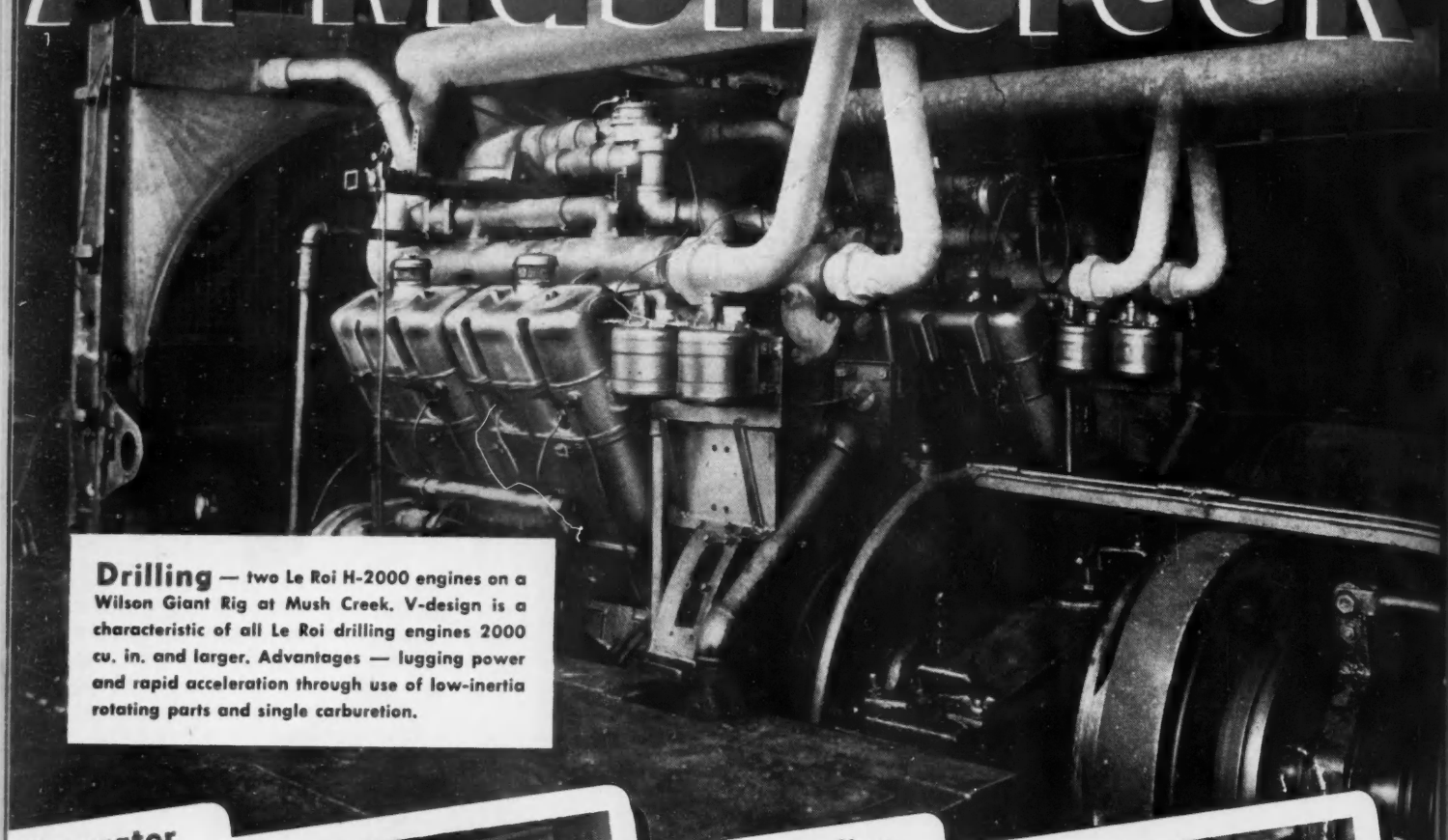
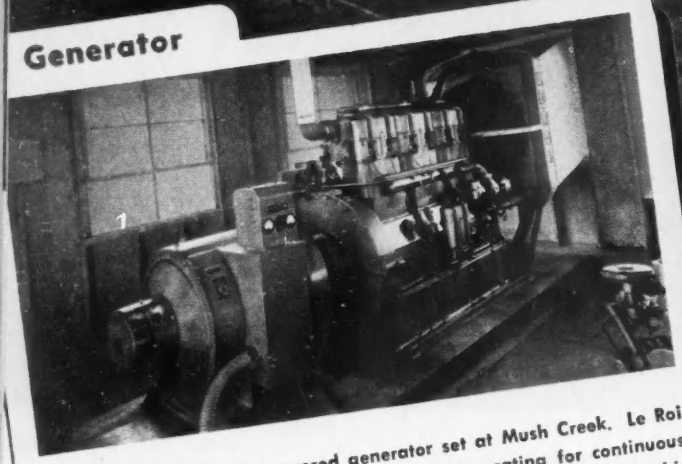
At Mush-Creek



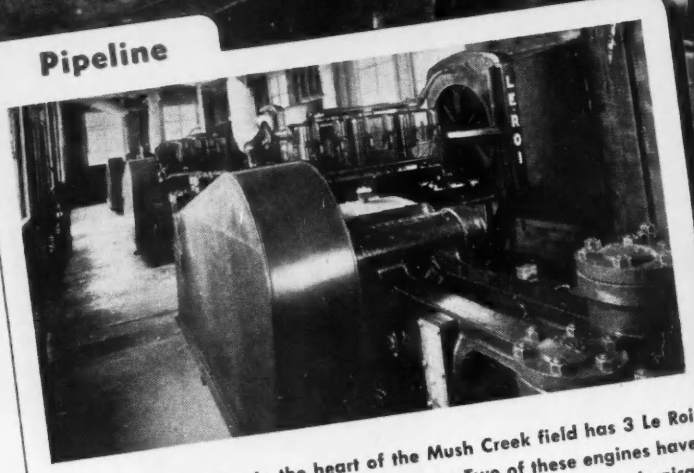
Drilling — two Le Roi H-2000 engines on a Wilson Giant Rig at Mush Creek. V-design is a characteristic of all Le Roi drilling engines 2000 cu. in. and larger. Advantages — lugging power and rapid acceleration through use of low-inertia rotating parts and single carburetion.

Generator



Here's a 75-KW Le Roi-powered generator set at Mush Creek. Le Roi engines (with their reserve power, conservative rating for continuous duty, good speed regulation, and low operating cost) are ideal for this type of service.

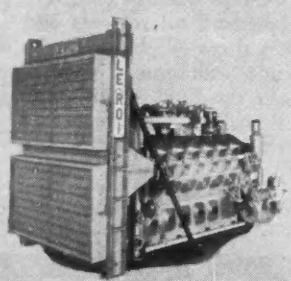
Pipeline



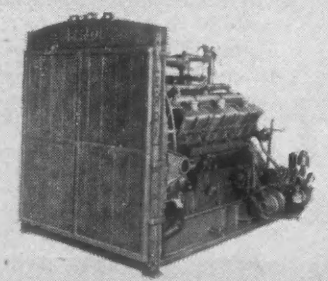
This pumping station in the heart of the Mush Creek field has 3 Le Roi F-1500 engines driving reciprocating pumps. Two of these engines have operated continuously for 27 months with no downtime for mechanical failure or even valve grinding. This is real proof of Le Roi dependability.

P-109

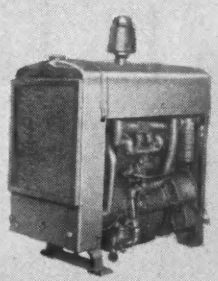
There's a Le Roi Engine for Every Oil Field Need



L-3460
HP range 280-600



RX Series
HP range 79-410



D Series and H-540
HP range 6-155

A Typical Le Roi Service Facility

This service shop, equipped with the finest tools available for engine overhaul, belongs to the Gehring Equipment Co., Casper, Wyoming. Gehring provides prompt service to an area stretching from the southern boundary of Colorado to the Canadian border. They maintain the only complete engine parts stock in the Rocky Mountain area. Emergency cases are handled by plane. It is because of service like this that you can always depend on Le Roi.

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SONOSCOPE combines ultrasonics, magnetics, and electronics into a vastly superior and more economical inspection method in which the human element is eliminated. With SONOSCOPE not only are physical discontinuities determined and evaluated, but variations in the internal structure of the metal itself are located accurately and recorded in permanent graph form.

SONOSCOPE not only prevents costly failures from occurring in drill pipe, but it also eliminates the waste of discarding pipe which is still serviceable. With unmatched precision in the non-destructive testing of oilfield pipe, SONOSCOPE permits a scientific estimate to be made of the future useful life of each length of pipe.

Further details are available on request.

** The Names SONOSCOPE and TUBOSCOPE are registered in the U. S. Patent Office.*

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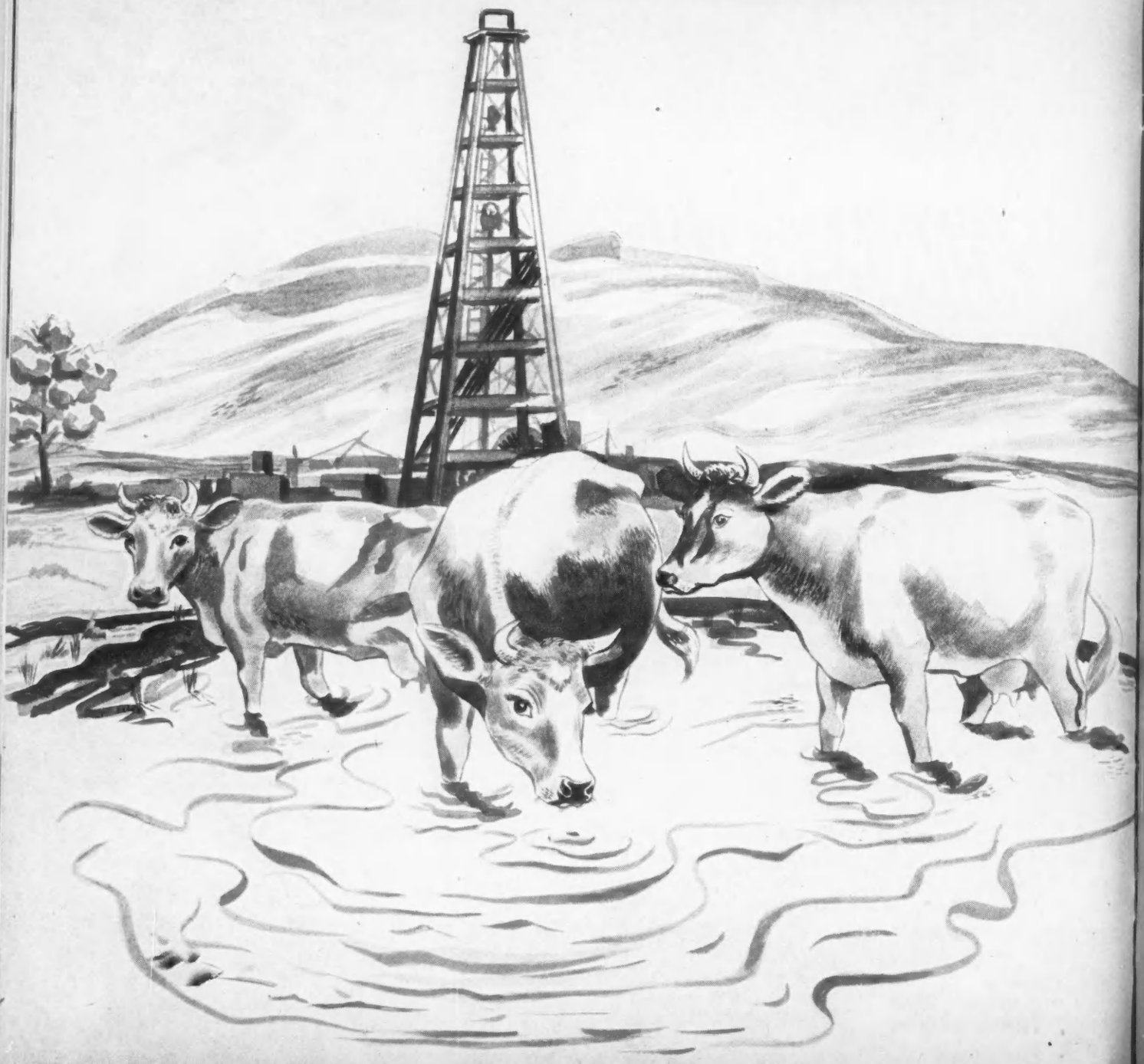
DRILLING MUD A SCIENCE



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The improvement over the regular Koneshot gun not only increases the ...ber of shots ...n, but also ...le densities ...o the hole. ...the F-2 is ...ic combi- ...h can be

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...brief explanation of the manner in which ...stream is formed may be given as ...

...the explosive in the charge ...row band of unex- ...h is indicated

The Lane-W... a high explo... explosive t... of focusir... cavity is ... oped i... sive ... tiali...

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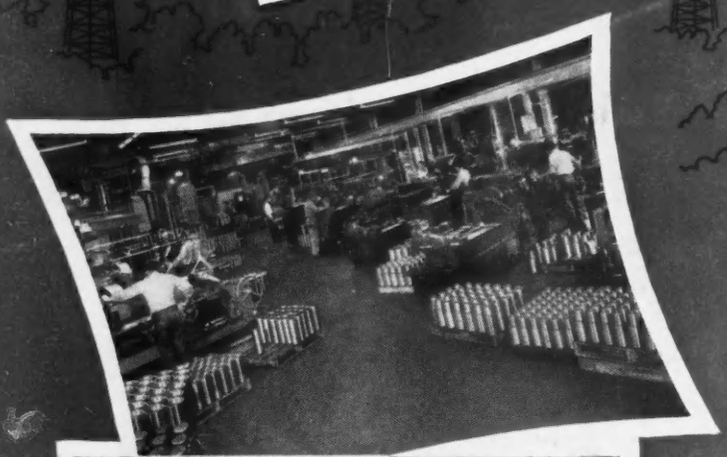
MORE THAN 27 YEARS



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